METAL INDUSTRY

30 MAY 1958

Applied Research

ONE of the major criticisms levied against research by the more practically minded is that all too often it is up in the clouds and that therefore its results cannot be applied on the shop floor. Perusal of the Annual Report of the British Non-Ferrous Metals Research Association would do much to dispel this illusion, for in whatever branch of non-ferrous metallurgy one is interested, something will be found of practical value.

Take, for instance, extraction and refining. Here a method has been developed to get rid of lead and tin when fire refining copper, particularly wire and cable scrap, which has halved the furnace time from two days to one and has reduced the amount of copper entering the refining slag from about 5 per cent to about 1½ per cent of the charge weight. In the foundry, where running and gating, still largely a moulder's art, are becoming increasingly influenced by the application of scientific principles, rules for the design of systems suitable for different types of castings are being drawn up. Work on the permissible limits of sulphur in gunmetals and phosphor bronzes is being followed by a similar study of the effects of antimony, arsenic and iron. With the high sulphur content of the cheaper fuel oils, sulphur pick-up is inevitable, but no evidence has been found that this is harmful and the tight limits in many foreign specifications seem unnecessary.

In modern press-work production exacting demands are made on the supplies of brass and copper for strip, for close control over thickness and freedom from "edge bow" along the length to ensure free running through multi-stage presses. A simple and satisfactory way of preventing "edge bow" is being developed and semi-scale plant for demonstrating its applicability to coils of different materials is approaching completion. Other researches on the working of copper alloys include studies of rolling loads, "shape" of rolled strip and lubricants for wire drawing.

With all materials the development of special properties for special applications entails some sacrifice of other desirable characteristics. Thus, the high strength alloys used by the aircraft industry for main structural members are inclined to have little ductility when stressed across rather than along the length. A detailed investigation of the effect of the cast structure of the billet from which the member is made, and of the effect of composition and heat-treatment on the properties of the product, has provided a comprehensive understanding of the causes of this weakness. In the same field a substantial programme of work has been put in hand on notch sensitivity and fretting effects in fatigue of a range of aluminium alloys, making strictly comparable tests on steels.

Improvement of the service performance of decorative and protective coatings is the main work of the Association in the metal finishing field. One big step forward is the disproval of the belief, at one time widely held, that nickel plating from baths that had been operated for long periods had inferior corrosion resistance even though it looked satisfactory. Pilot scale tests lasting many months, on the main industrial processes used, demonstrated that the durability of the product was unaffected. Incidental to this work, the Association has put into the hands of the plater and his customer new tools for assessing the quality of the deposits. A new thickness meter is being marketed which provides a simple non-destructive test that can be used in the routine examination of most plated components. In parallel with this, a new test of the durability of a deposit of known thickness which simulates in a short time the effects of atmospheric exposure has also been developed. Equipment for carrying out this test as a regular check in industry is now being designed.

Out of the MELTING POT

Instructive Excursion

AMONG the abstracts of the very large number of Papers presented at the 60th Annual Meeting of the American Ceramic Society at the end of April, there are several worthy of consideration by metallurgists. In the basic science section, for example, they will find that Kuczinski's method of obtaining sintering kinetic data has been applied to refractory oxides by studying the increase in neck area between spheres in contact heated on a microscope hot stage. A hint of developments-competitive possibly to come is provided by results of further studies on ductility of ceramic materials: 180° bends have been made in heat-treated specimens measuring $\frac{1}{16} \times \frac{1}{16} \times 1\frac{1}{2}$ in. Another Paper gives food for thought as to why there is still precious little in the metallurgical field to place alongside an account of mass spectrometric investigations of the ionic emission from alumina, in which the emission from "pure" alumina of positive ions of elements expected in conjunction with aluminium (e.g. gallium), of alkali metals (sodium, potassium, caesium and rubidium) and of accidental contaminants has been observed. While cermets were avoided, consideration was given to various metal-ceramic associations in dealing with the effect of firing temperature on the adherence of silver to ceramics, with tensile and shear tests of the bond strength of metallizing on ceramics, the stress analysis of ceramic-metal seals, and with various refractory coatings on metals (for heat insulation of the skins of supersonic aircraft, and high temperature insulation of wire). Of direct interest was the series of Papers on refractory materials for the aluminium industry both in reduction and melting furnaces, and equipment for handling molten aluminium. In connection with the latter, aluminium nitride refractories capable of resisting attack by aluminium in the temperature range of 1,800°-2,000°C. would appear to provide the ultimate answer. The only cermet to receive consideration, apparently as an exception, was thorium oxide reinforced with short molybdenum fibres. The mechanical strength and elastic modulus of these cermets are somewhat lower than those of thoria alone, due to the presence within the material of numerous submicroscopic cracks, but the impact strength, thermal conductivity, and thermal shock resistance are higher.

Still Wanted

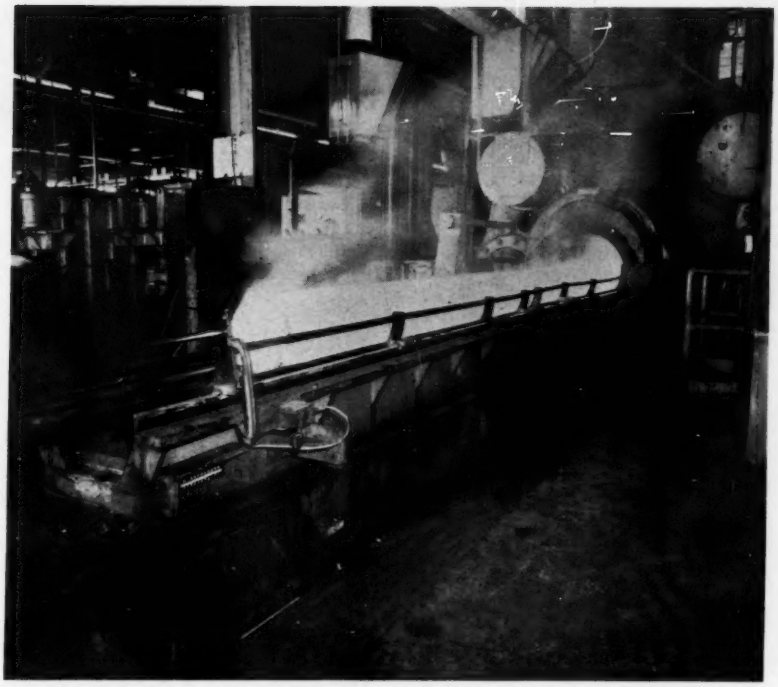
IN the absence of a black box capable of yielding the most unconventional power outputs that would enable studies to be made of the effect of plating current conditions far beyond the usual narrow range of just direct current densities, and the equally absent possibility of systematic investigations, it remains for more imaginative spirits to visualize periodic reverse plating procedures, procedures involving the application of short-duration high current density pulses, and complicated combinations of periodic reverse and alternating current sequences, and for the more adventuresome to rig up the necessary supply and control circuits. In the absence of what could be the results of systematic studies, it remains for inventors to hit upon, for example, a plating process comprising the steps of passing plating and deplating currents and also alternating current through the work to be plated, the plating and deplating currents being of such predetermined current densities and passing for such periods of time that the coulombs of plating current exceed the coulombs of deplating current, while the alternating current is passed through the work at least during the intervals of time between a deplating period and the next following plating period. The alternating current may also be passed during the intervals between each plating period and the next succeeding deplating period. Furthermore, the currents passed during the plating and deplating periods may consist in each case of a periodically varying unidirectional current composed of a direct current component with a superimposed alternating current component. The above method of plating is applicable generally, but has been found to be particularly advantageous in the plating of copper from a cyanide bath of usual composition. The interposition of the alternating current periods is thought to bring about a breakdown of electrolyte/deposit barriers, thereby increasing the current efficiency during the plating and deplating periods. The superimposition of the alternating current on the plating and deplating currents has been found to increase the tensile strength of the deposits and to reduce the amounts of occluded hydrogen.

Not so Perfect

SUCH excitement as was shown by metallurgists over the perfection of crystal structure which they thought to have at long last discovered in metal whiskers, the mechanical properties of which did indeed appear to accord with those to be expected from structural perfection was short lived. They have received the inevitable setback now that tin whiskers, with elasticities far above those of bulk tin, have been examined for perfection by X-ray diffraction. Straight, naturally grown whiskers, with diameters ranging from 1 to 15 microns, were examined. The whiskers were observed to have grown in a number of crystallographic directions (not all equally close-packed) with about equal frequency. An indication of their elastic properties is given for instance by an 11-micron diameter whisker 1·1 mm long, which could be bent into approximately a closed circle and when released would immediately return to its original shape, indicating a tolerable strain of about 3×10^{-2}. In the X-ray investigations, some data were obtained by means of a Geiger counter with CuKα radiation and some by photographic methods with MoKα radiation. Calculations based on these data were made to determine the cross-section of the crystallites normal to the whisker axis. It is thought that the dimensions of the crystallites along the whisker axis would not be much different from those obtained in other directions. The results give a crystallite size of 1·5 microns for a 5·5-micron diameter whisker, and 2·7 microns for whiskers of about 10 microns diameter. This means that the whisker crystals are not perfect crystals although they do have a greater degree of perfection than bulk specimens in general (where perfection usually extends less than 10^{-4} cm.). While the results obtained thus confirm an earlier suggestion that it was not necessary to postulate the absence of imperfections to account for the elastic properties of whiskers, they will no doubt stimulate new attempts to achieve a closer approach to perfection.

Skimmer

Extruding Titanium



Extruding a 40 ft. length of heavy wall tube

JET engine parts generally in the form of annular rings and tubular shafts, which were once made by forging or machining titanium billets or welded bar stock, are now being extruded at the Metals Processing Division of Curtiss-Wright Corporation, Buffalo, N.Y. A 12,000 ton horizontal hydraulic extrusion press, 126 ft. long, 22 ft. wide, 20 ft. high, capable of operating at a top speed of 22 cycles/hr., is used.

Typical titanium annular rings in unalloyed titanium (A70) and in the 5 per cent aluminium, 2½ per cent tin (A110AT) titanium alloy are being made for use as end flanges for sheet metal assemblies as follows:

(1) The basic cross-section of each ring is extruded in a straight length with a minimum machining envelope.

(2) Extruded lengths are contour-formed into 360° rings and flash-butt welded.

(3) Rings are sized and quickly machined to finished dimensions.

Thus, only half of the raw material once used is needed to manufacture the finished part. An additional saving resulted from the extrusion of sections directly from cast ingots rather than from forged billets.

In the development of this extrusion process, the press was equipped with containers to permit the extrusion of ingots from 8 in. to 24 in. in diameter with respective pressure stages of 4,000, 8,000, and 12,000 tons. For the 4,000 ton pressure stage, the 8 in. diameter container was used.

All stock was heated in a barium chloride salt bath adjacent to the press, and rapid transfer of the billets from furnace to extrusion chamber was made possible by an overhead hoist.

In extruding cross-sections, stock was added in the form of a circumscribed envelope. This envelope, approximately 0·050 in. thick, accounts for the tolerances attained and represents the extra stock used in machining parts to the finished dimensions.

To determine what portion of the envelope was required solely for the extrusion operation, a complete study of processing variables was performed on round sections. Optimum surface finish resulted from the combinations of extrusion processing conditions shown in Table I. These conditions were suitable for the extrusion of both the A70 and the A110AT materials as follows:

Nominal Metal Dimensions	*Extrusion Tolerances*
Less than 1·00 in.	±0·020 in.
1·00 to 2·00 in.	±0·030 in.
2·00 to 3·00 in.	±0·040 in.

This dimensional control was maintained for lengths of 100 linear feet for the A70 material; 15 linear feet for the A110AT alloy. For the A70 material, maximum lengths were obtained as five 20 ft. extrusions and in both instances die wear was the prime factor in length limitation. When better die materials and lubricants are developed, greater extrusion lengths will, of course, be practicable.

Differences in die life for the two materials indicated the greater resistance to deformation afforded by the A110AT alloy.

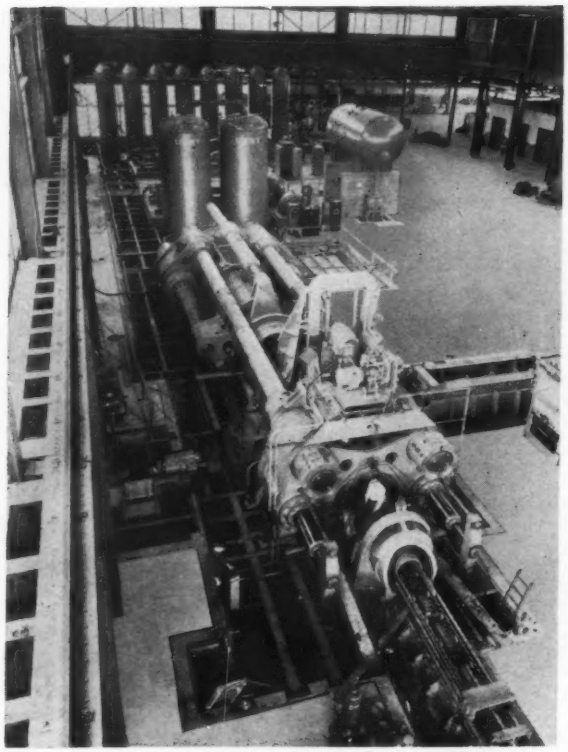
Conventional extrusion practice involves use of a billet which has been forged from an ingot to fit a specific container but in this process substantial savings were attained by utilizing cast ingots as extrusion stock. Thus, when

TABLE I—PROCESSING CONDITIONS

Condition	A70	A110AT
Extrusion Speed	450 in/min.	450 in/min.
Lubricant	Fiske No. 630	Fiske No. 630
Container Temperature	430°C.	430°C.
Die Preheat Temperature	400°C.	400°C.
Die Material	Vasco Supreme	Vasco Supreme
Die Design	120 to 140° Entrance Angle	180° Entrance Angle
Billet Heating	Salt Bath	Salt Bath
Billet Temperature	840°C.	1010°C.

TABLE II—COST COMPARISONS

Manufacturing Method	Conventional Forging	Extrusion	
		Forged Billet	Cast Ingot
Material Utilization (per cent)	19	26	30
Part Cost ($/lb.)	72	48	43
Cost Savings (per cent)	—	33	40



General view of the 12,000 ton hydraulic extrusion press for producing titanium rings

an extrusion is made directly from a cast ingot, both the cost of a forging operation and material losses are avoided. (See Table II.)

Quality tests indicated tensile properties well in excess of the minimum specification requirements for both the A70 and A110AT materials at extrusion ratios of 10:1 or more. Typical values are given in Table III.

For the materials studied, extruding above the beta transus (885°C. for A70 and 1055°C. for A110AT) was impracticable due to a severe loss of ductility and subsequent embrittlement. Conversely, excessively low temperatures had to be avoided in order to minimize pressure requirements. Extrusion temperatures of 945°C. and 1010°C. therefore represent a compromise.

The extruded shapes were formed into 360° rings with a radial draw former, which comprises a power-driven circular table and a double-acting pressure-controlled cylinder. This machine has a hydraulic cylinder that can apply a side force to a section being formed, if necessary, and it used both dies and materials which were preheated.

The A70 material was preheated to a temperature of 370°C. to 540°C. and the A110AT to 650°C. to 760°C. Die temperatures were 430°C. and 540°C. respectively.

Specific temperatures for rings depend on the complexity of cross-section and diameter in each instance; but, as indicated above, temperatures for A110AT rings are generally higher than those for the A70 alloy. Forming at too low a temperature in either instance can cause tearing on the tensile side of a ring.

In all cases, best results have been obtained where forming was done as slowly as possible. In addition, a two pass operation (first, with a clockwise rotation of the table; and secondly, with a counter-clockwise rotation) has been proved to be invariably desirable.

Tests were made with machined bar stock to determine the range of rib ratios that could be flash-butt welded to meet high strength and ductility requirements, and high quality welds were obtained for rib ratios up to 5·3 : 1.

This ratio is considerably larger than that occurring in any of the rings studied.

Machine settings for specific shapes varied considerably, as the following range of typical values will show:

Initial die opening	¾ to 1½ in.
Final die opening	½ in.
Flash burn off	⅜ to ½ in.
Upset Force	20,000 to 30,000 lb.
Flash time	3 to 12 sec.
Burn off length	¾ to 1⅛ in.
Clamping force	23,000 lb.

All the titanium rings were expanded on a 225 ton press brake at sizing temperatures of 370°C. to 680°C. This permitted an expansion of 2 per cent and 1½ per cent for the A70 and A110AT materials, respectively.

For small diameter, large-cross-section rings, an out-of-round condition due to welding had to be corrected by a rolling operation prior to sizing.

TABLE III—MECHANICAL PROPERTIES

	A70	A110AT
Tensile Strength (lb/in²)	100,000	135,000
0·2 per cent Yield Strength (lb/in²)	80,000	120,000
Elongation (per cent)	25	20
Reduction in Area (per cent)	40	35

Men and Metals

As chief executive, Chemicals Division, British Oxygen Limited, **Dr. R. F. Goldstein,** in addition to being managing director of British Oxygen Chemicals Limited, is now also managing director of Carbide Industries Limited and a director of Odda Smelteverk.

Previously with Philips Electrical Limited, **Mr. S. F. Smith** has recently taken up an appointment as sales manager of the Industrial Instruments Division of Firth Cleveland Instruments Limited. He will operate from the sales department of the company at Byron House, St. James's Street, London, S.W.1.

New appointments in the Industrial Group of the United Kingdom Atomic Energy Authority have been announced as follows:—**Mr. P. T. Fletcher,** B.Sc., formerly director of engineering, becomes a deputy managing director; **Mr. H. V. Disney,** C.B.E., M.I.Mech.E., formerly deputy director, defence plants, supplies and services, becomes director of engineering; and **Mr. R. V. Moore,** G.C., formerly deputy director civil reactors, becomes director of reactor design.

A senior sales engineer of The Solartron Electron Group Limited, **Mr. H. A. Ball,** is making a four-week tour of the Middle East. During his tour, Mr. Ball is visiting existing customers of the group in Lebanon, Iraq, Iran, and Turkey, and he will also give demonstrations of, and talks on, Solartron electronic instruments.

At the annual meeting of the National Association of Non-Ferrous Metal Merchants Golfing Society, held in London last week, the following officers were appointed for the ensuing year:—President, **Mr. P. A. Benson** (F. W. Harris (Birmingham) Ltd.); captain, **Mr. J. Castle** (John Castle and Co. Ltd.); and hon. treasurer, **Mr. L. E. Ricketts** (R. J. Coley and Son (Hounslow) Ltd.).

It is learned from The Glacier Metal Company Limited that **Mr. F. B. McPherson** has been appointed deputy managing director.

The Institution of Metallurgists

ANNUAL GENERAL MEETING

AT the annual general meeting of the Institution of Metallurgists, held on Tuesday, May 20, at the Park Lane Hotel, London, **Mr. W. E. Ballard,** managing director of Metallisation Limited, was elected President for the year 1958-59.

The following elections were also made:—President-elect, Professor A. J. Murphy. Vice-presidents: Dr. N. P. Allen and Mr. G. Meikle. Dr. E. G. West was re-elected hon. treasurer. Ordinary members of Council elected by Fellows: Professor J. G. Ball, Mr. N. I. Bond-Williams, Professor G. V. Raynor. Ordinary member of Council elected by Associates: Mr. V. S. Kingswood.

Presidential Address

In the course of his Presidential Address, Mr. Ballard, after dealing with the early history of the Institution, said:—

During those early days not every metallurgist was in sympathy with the Institution, but I want to emphasize that not one single person who took part in the formation had anything to gain personally. All were established in their profession, and they sought to obtain for younger men and women advantages from which they themselves had not benefited.

It is unfortunate that many young metallurgists, having obtained a university degree, think that at the outset of their career the L.I.M. or A.I.M. is of little use to them. Their instructors should have told them that a degree signifies that they have a certain qualification, but that the letters of our Institution mean much more; they imply, in addition, actual practical experience and are the symbols that other metallurgists believe them to be worthy of membership of a profession. Those mainly responsible for our foundation were men of highest academic qualification but who realized the obligations of a vocation.

At refresher courses and other places where metallurgists are gathered together, I have heard younger members criticizing the organization by which they are employed, whether it happens to be an industrial firm, a research organization, or a government department. The complaint is that there is a lack of opportunity, the most important posts being held by administrators, accountants, and the like.

While many members of the Institution occupy very high positions, the proportion of metallurgists doing so appears to me to be less than it should be.

Many older members in positions of authority, while admitting freely that to-day young metallurgists are better

Mr. W. E. Ballard

trained than ever before, state that there is a marked tendency to evade responsibility if possible. There are, of course, exceptions, but this does appear to be a view widely held.

It seems quite certain that some cannot express themselves in public speaking, or even in writing, and quite a few candidates for our examinations cannot read to understand; they find ambiguity where none exists.

There is now a somewhat despised method of entering ferrous metallurgy, that is, by way of the shift system—first in the laboratory and then on the shop floor. It is from the personal point of view an inconvenient road, but those taking it get to know the practical men in the works. In my early days I did shift work in the non-ferrous industry, and if things went wrong in the night, one did not telephone the boss until one had done things. You would probably be successful if you listened to the advice of those who, by the sweat of their brows, knew how to do the job if not the reasons why they achieved results. In this way, one made use of metallurgical history and tradition. I think there is evidence that to-day this study of human beings does not get the emphasis it deserves.

In the metallurgical industries there are usually three streams of recruitment to executive positions: the first, the administrative professions — sales and accountancy; the second, engineering or production; and the third, development and research, including metallurgy. It seems to me that there is a danger that the person in the third stream tends in these days to be furthest away from humanity, and hence is likely to be lacking in confidence. Only by contact with others can full development take place.

To the younger members I would say: take every opportunity of studying people, be willing to learn from the lowliest, develop yourselves as individuals and not as pale copies of those above you, as that way leads to snobbery and to ultimate disillusion. To the older members, may I plead that you give the juniors the opportunity to mix with their colleagues, and if possible in business with customers and suppliers.

To those engaged in research I still feel the human contact is essential, and by it the tendency of the research worker to forget that time matters would be overcome, because he would realize the part his occupation had in the social structure.

We have achieved much in a short space of time, but we still have a long way to go. We must be ready to defend our members against wrongful dismissal, or dismissal without adequate notice. We must advise on the matter of service agreements. We should join with other professional bodies in approaching the universities to remove certain anomalies in their methods. We should join in representing to the Chancellor of the Exchequer certain injustices of the tax position regarding professional men.

It is our duty to see that everyone in the profession is properly qualified to carry out his duties and obligations to the community, as well as to see that everyone so qualified is a member of the Institution.

In the discussion which followed the Presidential Address, **Mr. E. R. Perry** moved as a notice of motion that time be allotted at the next annual general meeting for discussing the possibilities of an amalgamation, within the next ten years, of the main metallurgical societies concerned with processing metals, notably this Institution, the Institute of Metals, and the Iron and Steel Institute.

Annual Luncheon

At the annual luncheon, with the President in the chair, the principal speakers were Sir Gilbert Flemming, K.C.B., Permanent Secretary, Ministry of Education, and Mr. A. G. Stewart, chairman and general managing director, Stewarts and Lloyds Limited.

Other distinguished guests included Lord and Lady Kirkwood; Lt.-Cmdr. Christopher Powell, secretary of the Parliamentary and Scientific Committee; Mr. S. E. Clotworthy, President, Aluminium Development Association, and Mrs. Clotworthy; Mr. J. B. Dennison, President, Institution of Mining and Metallurgy, and Mrs. Dennison; Dr. T. P. Hoar, President, Institute of Metal Finishing, and Mrs. Hoar; Mr. A. R. Mathias, chairman, Lead Development Association, and Mrs. Mathias; Mr. A. A. Part, Under Secretary (Further Education), Ministry of Education, and Mrs. Part; Mr. R. T. de Poix, chairman, Zinc Development Association; Dr. G. B. B. M. Sutherland, director of National Physical Laboratory, and Mrs. Sutherland.

Products and Processes

TRENDS IN THE DEVELOPMENT, APPLICATION, PROCESSING, DESIGN AND WORKING OF NON-FERROUS METALS AND THEIR PRODUCTS

Agitation in Frozen Mercury Casting

IN the Mercast (or frozen mercury) process, operated by Sankey-Telcon Ltd., at Crawley, the only installation of its kind outside the U.S.A., an air-operated portable stirrer recently introduced by the Kestner Evaporator and Engineering Co. Ltd. has been quickly pressed into service in the making of ceramic moulds for precision castings.

This process, for precision casting of magnesium and aluminium alloys, beryllium-copper and heat-resisting alloys, uses closed steel dies into which mercury is poured, and the assembly is then lowered into a refrigerated bath of acetone at −70°C. and the mercury frozen solid. When this has been done, die and mercury are withdrawn, the die is opened and the solid mercury pattern revealed. Frozen mercury welds to itself when two pieces are lightly pressed together. This enables one to produce accurate internal and external forms by preparing the pattern as several parts which can then be joined precisely in a jig. The pattern is dipped repeatedly at low temperature in a ceramic slurry to build up a thin shell mould around it, usually to a thickness of $\frac{1}{16}$ in. to $\frac{1}{8}$ in. The mould and mercury in it are then allowed to come up to room temperature, when the now liquid mercury flows out, leaving the "green" mould. This is fired at a high temperature for 2 hr., and becomes a hard, strong, inert structure suitable for forming the mould for the type of casting mentioned above.

The Kestner stirrer has become an essential part of the process. The temperature throughout the mercury freezing tank must be kept as uniform as possible, and this can only be done by the type of agitation so provided. It is considered that the acetone vapour in the tank above the surface might provide an inflammable mixture with air, and so the air motor-operated stirrer is used.

These stirrers are additional to those Kestner types driven by totally enclosed or flameproof electric motors. The air motor is a rotary vane one suitable for working pressures of up to 90 lb/in^2, with integral sun and planet reduction gear driving a stainless, or plastics-coated, shaft which is fitted with two opposed propellers. Compared with the conventional electric motor, they are small, compact, of light weight, and, by reason of the air control, have great flexibility, permitting variable speed operation.

Below: The air motor-operated Kestner stirrer in operation. A die nearly full of mercury can be seen on the left

Hardening Large Rolls

INEVITABLY, in the course of rolling sheet and strip, the hardened and highly finished outer surface of the roll becomes fatigued, develops cracks, and the roll becomes unserviceable. To scrap it, however, is uneconomic, and a great deal of trouble is taken in reconditioning the worn surface. By old methods this was troublesome indeed, since it is important to reharden only the working surface, excluding the necks at each end, yet avoiding any distortion.

To meet this problem, Birlec Limited and William Beardmore and Company Limited, Glasgow, have developed jointly a new induction heating equipment. Induction heating has the great advantage of selectivity, permitting the work to be heated over a clearly defined area and to a predetermined depth below the surface, thus removing any risk of heating the roll necks or distorting their axial alignment.

The first Birlec machine of this kind is now in operation. Designed to handle rolls up to 18 ft. overall length and up to 32 in. diameter, the machine supports the work vertically, between centres. The lower centre is motor driven to rotate the roll slowly during hardening. The structure which supports the upper centre in guides to provide for height adjustment, also carries slideways on which the heating head can be traversed over the length of the roll.

Heating of the roll is effected by high frequency eddy currents induced in it by a water-cooled coil. A radiation pyrometer is provided to assist in controlling the temperature attained. Different coils can be interchanged easily so that the optimum clearance from the work, to give efficient energy transfer, can be maintained for any roll diameter. With the coil mounting, on the travelling head, is incor-

Right: Induction heating equipment for hardening large rolls

porated a water manifold arranged to flood the heated roll surface. Thus, heating and quenching operations occur in succession, and the hardened zone spreads over the desired area as the heating head traverses the length of the roll.

High frequency power is provided by a 400 kW motor alternator set, operating at 1,000 cycles/sec. Unity power factor is assured by a bank of capacitors, the value of which can readily be adjusted by switching. Alternator voltage is closely governed, irrespective of load, by an automatic regulator of a highly-sensitive electronic type which permits the heating power to be pre-set at any desired level and held constant throughout the operation.

Normal operating procedure involves pre-heating the roll at low power, with the quench water turned off, followed by a single hardening pass over the predetermined zone. Traversing speed and power level during hardening can be set as required to produce a hardened surface of appropriate depth for each type of roll.

With this new Birlec machine, a large roll can be pre-heated and hardened in about 1 hr. The hardness pattern can be controlled within close limits and distortion of the complete roll is negligible. Compared with the methods previously used, the process has great economic and technical advantages and marks an important step in roll hardening technique.

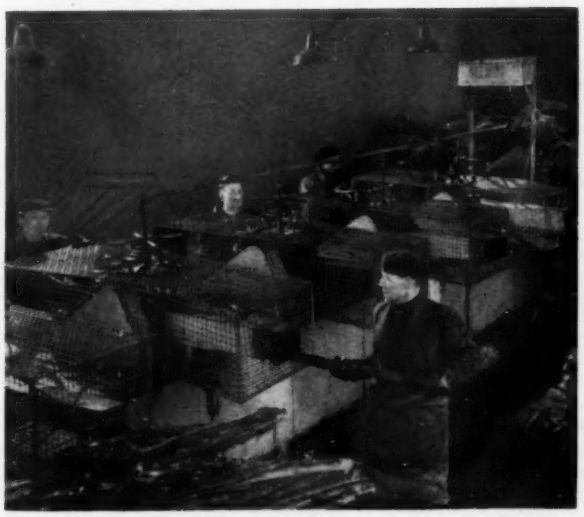
Recovery of Cable Scrap

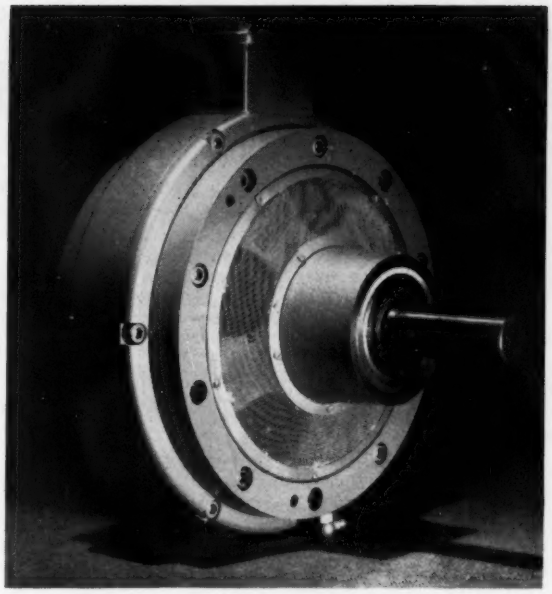
ONE of the many problems involved in the recovery of scrap is that of cable stripping. Consequent upon the introduction of the Clean Air Act, mechanical stripping has assumed even greater importance, and F. C. Larkinson Limited have developed a cable stripper that has practically eliminated burning.

The layout of this five-headed cutting machine comprises, in No. 1 position, a heavy loading unit for cables over 4½ in. overall diameter. As with all units, the cutters are driven from both top and bottom, and are capable of severing through all the protective coverings of underground cable, that is, bitumen, double steel tape or steel wire armour, lead sheathing, and paper belting. After passing through the machine, the paper-covered conductors are shaken out of the lead and armoured cases and put on one side for processing in the paper stripping section of the machine.

Units 2, 3, and 4 of the machine are similar in all respects to Unit 1, with the exception that they are graded both as regards speed and cutting heads for the processing of cables which have reduced overall diameter. The 5th unit on the machine has very high-speed, flat, knurled cutting blades, through which the paper-covered copper cores are processed under heavy spring pressure, and between the fast rotating cutters. The oiled papers are stripped clean from the copper conductor. The four main cable cutting units are supplied with recirculating cutting suds that both lubricate the cutting blades and continuously wash away accumulation of bitumen that will otherwise clog and mar the efficiency of the draw pinions. Each unit has an independent electric motor drive, operating through the gear box and duplex chain drive, to the lower draw pinion. The top draw pinion, which is also driven, derives its power from a secondary chain drive provided with tension jockey sprocket, which provides for the vertical displacement of the cutting blades and draw pinions to accommodate for slight variations in the external diameter of the cables being processed. From the safety aspect, each head is fully enclosed by wire guards, and on both sides of each operator's position are placed emergency stop buttons which isolate each section of the machine.

Five-headed cutting machine for stripping cable





Smiths magnetic particle coupling type SFU 550/50 for industrial drives

Constant Torque

AN electro-magnetic form of drive coupling, having the resilience of its fluid flywheel counterpart with the stability of a solid device, has been introduced by S. Smith and Sons (England) Limited for industrial drives. The coupling is a constant torque unit, the torque being independent of speed, and has a safety feature permitting a certain amount of slip when necessary. There are no moving engaging components.

These couplings are available with torque capacity of ¼, 1, 6, 12, 25, 50, 100, or 200 lb/ft; and operate from 24 V or 180 V D.C. as standard, though special voltages can be catered for.

During the take-off period, the coupling operates with a smoothness and an absence of jerk or judder met only in hydraulic devices. On the other hand, under full excitation, the coupling will become solid, there being no slip, and, therefore, no generation of heat and no loss of efficiency. The dynamic and static co-efficients of friction are equal.

Power consumption varies, of course, according to the size of the coupling—for the 50 lb/ft coupling it is 72 W.

By its very nature this coupling is especially suited to automation. The consistent relationship between output torque and excitation current values from a static condition up to a locked-in condition makes it most suitable to control from a sensing device which is associated with the process under consideration.

INVESTIGATION OF METHOD FOR MOULDING METAL POWDERS

Metal Ceramics

By W. D. JONES, M.Eng., Ph.D., F.I.M.

NOWADAYS, the term "metal ceramics" has come to mean the manipulation of mixtures of metal and ceramic powders together by the processes of powder metallurgy. Strictly speaking this term is incorrect, and what it *should* mean is the manipulation of metal powders *as if* they were ceramics. That of course, implies, among other things, for example, the handling of metal powders as a sculptor or a potter handles clay—by hand moulding or by spinning on a wheel—followed by baking.

Thinking along these lines caused the writer recently to ask—why not? This article is an account of some recent rather unsuccessful experiments to undertake genuine metal ceramics.

Several things appeared to be necessary:—

(i) A binder of some sort must be mixed with the metal powder in order to permit it to be moulded, and the moulding must have sufficient rigidity to allow it to retain its shape.

(ii) The binder must maintain the shape of the moulding during the sintering heating-up period until the metal powder itself starts to sinter, and then provides its own rigidity.

(iii) The binder should then volatilize during sintering, leaving no trace of any kind and without interfering in any way with the sintering process. (This eliminates, for example, starch paste.)

Several other matters appeared also to be very desirable:—

(i) The binder should not react chemically with the metal. (For example, water in conjunction with iron.)

(ii) The binder should have a reasonably low volatility to allow sufficient time for the manipulation.

(iii) The binder should be non-toxic and reasonably non-inflammable nor explosive.

(iv) Whilst it would be permissible to allow for a preliminary drying-out period before sintering, it would be very attractive if the moulded body could be put immediately into the sintering furnace.

(v) The binder should not attack the sintering furnace.

Given an answer to all these requirements, there should be no reason why large objects in all types of metals should not be manufactured, just as vases and pots are spun on the potter's wheel, and then immediately sintered, without even allowing for the lengthy drying-out period that has to be given to ceramics. With this vision in view, the writer began to examine the possibilities of finding suitable binders and, with the experimental help of F. B. Webb and R. Woolfall, of F. W. Berk and Co. Ltd., all the problems *but one* appear to have been solved.

TABLE I—SOLVENTS TESTED

	Boiling Range °C	Flash Point °C	Evaporation Rate*
Methyl amyl acetate	143—150	110	47
Ethylene glycol diacetate	186—195	205	2
2-ethylhexyl acetate	195—205	190	3
2-methoxyethyl acetate	137—152	140	31
Ethyl benzene	134—137	85	91
Carbitol acetate	213—223	230	<1
Deca hydro naphthalene	190—200	160	10
Tetra hydro naphthalene	203—220	185	3

**N-butyl acetate*=100

The problem of a binder which will retain rigidity during heating up and will then volatilize without trace in a reducing atmosphere appears to be quite a simple one. Both polystyrene and polythene will do this admirably. Mixed with a metal powder and heated up rapidly, polythene volatilizes from the mass over the range 300°-450°C. and polystyrene over the extended range 250°-850°C., and these are quite satisfactory for holding the particles in place until sintering commences (at least with copper- and iron-based alloys). Neither of them appears to react with the metals or the furnace. Neither of them leaves behind any carbonaceous residues nor appears to interfere in any way with the sintering process.

There are a large number of solvents for both of these plastics. Limiting the choice to those which are reasonably non-toxic, non-inflammable, and non-corrosive, those listed in Table I were experimentally examined.

Using these as solvents for polystyrene crystals (dissolved at temperatures near the boiling points), all gave some kind of performance, but on the grounds of slow evaporation rate and high boiling point and flash point, tetra hydro naphthalene is to be preferred, and in point of fact appeared to give the best moulding properties.

Using 200 mesh copper or 89:11 bronze powders having the highest possible apparent densities, stiff clay-like pastes were made by mixing 4 to 6 mL. of a 10 per cent solution of polystyrene per 100 gm. of metal powder. Considerable working (pugging) was necessary. Small objects could readily be moulded with the fingers, and suffered little loss by evaporation in 24 hr. It was possible to put such moulded objects directly into a sintering furnace in a hydrogen atmosphere, and heat them up quickly to the sintering temperature (950°C. for copper, 785°C. for bronze) without any loss of shape or distintegration during evaporation of the solvent and the polystyrene. No interference with sintering appeared to take place, and no carbon was left behind.

Very similar results were obtained with polythene. In this case, paraffin was found to be a suitable solvent and a pasty mass was prepared by melting polythene under paraffin (3 gm. powdered polythene to 250 mL. of paraffin) and incorporating 15 mL. of this paste with 100 gm. of the metal powder.

Whilst these techniques permitted the successful moulding and sintering of small objects, unfortunately the rigidity of the masses was not sufficiently good for large objects. Any shape (such as a cone or cup) larger than approximately 2 in. diameter tended to collapse slowly even at room temperatures.

It is clear, therefore, that improved binders imparting a considerable degree of thixotropy must be sought, and it is hoped that the publication of these results may bring forth some suggestions.

Emission Spectroscopy

RECENTLY published by Hilger and Watts Limited, Volume V of "Spectrochemical Abstracts" covers the years 1952-1953 and continues the work of the first four volumes. The abstracts relate to emission spectroscopy in its analytical applications; flame spectroscopy is included but not X-ray emission spectroscopy. The abstracts are numbered consecutively, this volume beginning at 1690, where the previous volume ended. A classified index, an author index, and an index to elements observed as minor constituents of samples helps to simplify reference.

These abstracts are edited by E. H. S. van Someren and F. Lachmanp, and are available from Hilger and Watts Limited, 98 St. Pancras Way, London, N.W.1, price 20s. 0d.

INDUSTRIAL DEVELOPMENT SINCE 1945 YIELDS INCREASED PRODUCTION

Non-Ferrous Metals in Yugoslavia

SINCE World War II, Yugoslavia has developed production of non-ferrous metals considerably. In the production of lead contained in ores, Yugoslavian output in 1956 amounted to 22·4 per cent of the European, and 4·2 per cent of the world output. Production of copper from ores amounted in 1956 to 19·6 per cent of European and 0·9 per cent of world production. Bauxite production amounted to 20 per cent of European and 5·7 per cent of world production.

In terms of production of zinc contained in ores, Yugoslavia holds the sixth place in Europe. This production forms 8·5 per cent of European and 2 per cent of world production. In 1955, silver production amounted to 29·4 per cent of European and 1·3 per cent of world production. The position is similar with mercury. In 1956 the production of mercury amounted to 15·2 per cent of European and 7 per cent of world production.

Production of other non-ferrous metals has likewise been developed, this including alumina, aluminium, antimony, bismuth, gold, cadmium, selenium, chrome ore and chrome concentrate, pyrites concentrate, wolfram concentrate, etc. The production of ferro alloys has also developed in Yugoslavia, including ferromanganese, silicomanganese, ferrochrome, ferrosilicon, silicocalcium, silicochrome, as well as certain other ferro alloys.

During the post-war period, industry has been developed for processing metals, including particularly rolling mills and cable industry. Thus, at present, rolling mills capacities of about 38,000 tons of rolled copper and copper alloy goods are available, as well as about 25,000 tons of cables, insulated conductors and dynamo wire and, further, 26,000 tons capacity for the production of aluminium and aluminium alloy rolled goods. In addition, rolling mill capacities are available for the production of lead sheets, tubes and shot totalling about 9,000 tons. Rolling mill capacities for the production of zinc sheets, etc., are also available. Special attention has been devoted to the development of non-ferrous metallurgy.

Production and exports of some non-ferrous metals during the period from 1946 to 1956 inclusive are shown in Table I.

Actually, the exports of non-ferrous metals were even greater, particularly during the later years, because copper and some lead were exported in the form of electrical cables and conductors, so that they were not included under the exports of non-ferrous metals. The case is similar with other products: chromium in chrome-magnesite bricks, mercury in chemical products, etc.

TABLE I—PRODUCTION AND EXPORTS

Product	Production 1946 to 1956 inclusive (tons)	Exports from 1946 to 1956 inclusive (tons)	Per cent
Lead*	697,515	608,777*	87
Copper†	349,673	151,720	43
Bauxite	4,804,024	4,022,242	84
Mercury	4,903	4,386	89·5
Antimony	16,342	14,601	89
Bismuth	815	737	91
Silver	761	748	98
Pyrites concentrate	1,827,062	1,371,250	75
Chrome ore I and II and chrome concentrate	562,530	440,560	78·5
Ferromanganese	57,861	23,458	41
Ferrochrome	27,873	23,300	85
Zinc‡	128,683	39,645	30·6
Zinc concentrate	674,326	335,055	50

**Lead includes* 35,000 *tons of lead produced and exported in lead concentrate and* 1,034 *tons of rolling mill lead products.*

†*Copper includes the production of blister copper. Exports of blister copper, electrolytic copper and rolling mill goods of copper.*

‡*Exports of* 2,560 *tons of zinc manufactures.*

Exports of non-ferrous metals have increased from year to year. Thus, for instance, after the completion of the Bor copper electrolysis plant in 1953, no blister copper was exported but only the electrolytic product. With the completion of the large copper processing plants, the Copper Rolling Mills, Sevojno, and the Cable Works, Svetozarevo, since 1957, copper exports practically ceased, while the exports of rolled copper goods and cables were considerably increased. Concentrate of zinc constitutes a similar case in point. With the completion of the zinc electrolysis plant at Sabac and increased capacity of the Zinc Works of Celje, Yugoslavia produced in 1957 over 29,000 tons of zinc, or more than twice the 1955 figure. The case is similar with the aluminium industry which will, as a result of the construction of the aluminium rolling mills in the Light Metal Works, Sibenik, and the reconstruction of the "Impol" Rolling Mills, near Sl. Bistrica, export aluminium rolled goods instead of aluminium ingots, etc.

Non-ferrous metal ore reserves so far determined, and the unexploited power supply resources, particularly hydro-power, ensure a further significant increase in the production of non-ferrous metals Thus, for instance, the copper reserves in copper ore deposits at the end of 1956 amounted to 2,338,000 tons, lead metal reserves in lead-zinc ores to 1,500,000, and zinc metal to 1,100,000 tons. About the middle of 1956, the bauxite reserves amounted to 128,000,000 tons, with 55·4 per cent of Al_2O_3 and 3·52 per cent SiO_2. Yugoslavia's hydro-electric power potential, economically exploitable, amounts to 66,550 million kWh, of which only 4 per cent has been utilized so far.

With the completion of the Majdanpek project, which comprises the building of a new copper smelting plant and sulphuric acid plant at Bor, the present copper production will be increased by another 25,000 tons per annum, so that after 1961 copper production in Yugoslavia will be stepped up to the level of 55,000 tons.

In addition to copper, significant quantities of gold, silver and pyrites concentrate will be obtained. New copper mines are being exploited, the capacity of which by 1962 should amount to 570,000 tons, including 25,000 tons of copper constituting the capacity of the Majdanpek mines. This project will be partly financed from the loan contracted by Yugoslavia in France and Belgium.

To develop her aluminium industry, Yugoslavia concluded in 1956 a loan in U.S.S.R. and the German Democratic Republic for the building of combined aluminium works in Titograd, whose first stage of production should amount to 50,000 tons of aluminium and 100,000 tons of alumina. With the completion of the second stage of the aluminium electrolysis plant at Kidricevo, with a

capacity of about 20,000 tons, Yugoslavia will, after 1964, produce approximately 100,000 tons of aluminium, as compared with 18,000 tons produced in 1957. The combined aluminium works, Titograd, are scheduled to come into production in 1964, and the second stage of the electrolysis plant at Kidricevo in 1961.

Two new lead-zinc mines are to be opened at Srebrenica, in Bosnia, and Kisnica, in the autonomous region of Kosovo and Metohija. These two mines will yield lead and zinc concentrates, which will facilitate the production of about 100,000 tons of lead, 6,000 tons of zinc, and about 15 tons of silver. These mines are to come into production in 1960.

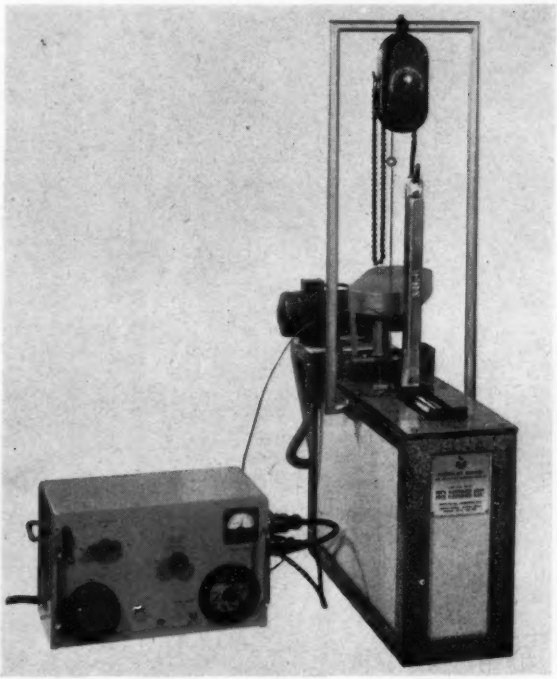
Among other capacities, the mercury smelting plant in Idria is to be increased by about 70 to 80 tons of mercury per annum, and the zinc electrolysis plant at Sabac from 12,000 to 18,000 tons. To this should be added the increase of the ferro alloy capacities which are now in the completion stages (Electrode and Ferro-alloy Works, Sibenik, Ferro-alloy Works, Jegunovci, Macedonia).

Soldering Printed Circuits

DESIGNED to eliminate the difficulties and problems involved in the conventional flat dip-soldering of printed circuits, the "Flowsolder" unit lifts the molten solder up to the circuit instead of lowering the circuit panels down to the molten solder, as is done with ordinary dip-soldering units. The technique has been developed by Fry's Metal Foundries Ltd., Tandem Works, Merton Abbey, London, S.W.19, who manufacture the Flowsolder unit.

The solder is raised up to the circuit panels by an impeller pump, which forces the metal upwards through an elongated nozzle so that it forms a stationary wave. The circuit panel is passed through the crest of this wave of molten solder, which solders the joints between the component leads and the copper conductors on the underside of the panel.

The passage of the panel through a wave of constantly flowing solder provides a more rapid heat transfer from solder to panel, which reduces dipping time, and assures consistently sound joints and soldering at a well-defined controlled temperature. Surplus solder drains back into the bath so that it does not form bridges between adjacent conduits. The solder is always on the move at the right temperature and surface chilling is eliminated.



The Flowsolder unit, developed to improve the technique of soldering printed circuits

Angled entry and exit are automatically provided by the shape of the solder wave. This feature, together with the washing action of the moving solder, prevents trapping of flux or air and assures sound joints.

Since the panels move along a straight path, the transfer mechanism design is simplified and hesitation or break in the production flow are prevented.

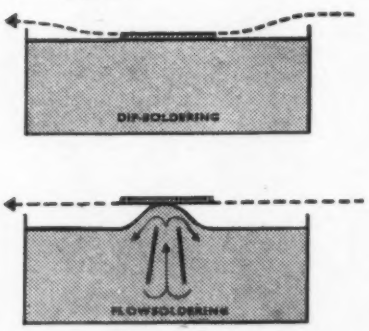
Only a 2 in. wide strip of the panel is in contact with the molten solder at any given time, thus reducing warping of the panel and heat damage to components.

No skimming is necessary with the "Flowsolder" machine. The molten solder welling up through the nozzle is drawn from below the bath surface and is, therefore, always clean and free from oxide or dross.

Elaborate level control to close limits is unnecessary, because the height of the wave is easily regulated by adjusting the speed of the metal pump which forces the molten solder upwards through the nozzle. The level of the bath is always kept constant within convenient limits by using a float controlled automatic ingot feeder, which lowers a specially shaped "feeder ingot" of solder into the bath, whenever it needs replenishing. This provides a constant supply of pre-treated solder to the bath and avoids temperature fluctuations which would arise from adding fresh metal at intervals.

Flat-dipping is not suitable for the long panels sometimes used for special assemblies. The "Flowsolder" system, with an 8 in. nozzle, will handle panels up to 7½ in. wide, up to any practical size in length.

In dip soldering the circuit frame is dropped into the solder bath (top) but in the Flowsolder method the panel is passed across the crest of the wave of solder



Pumping Fluids

IN the issue of METAL INDUSTRY, 4 April 1958, page 276, the article describing the portable electric barrel pump manufactured by British Central Electrical Co. Ltd. referred to the thermal cut-out operating at 60°F. We are now advised by the manufacturers that this should, in fact, have been given as 160°F.

Finishing Supplement

Institute of Metal Finishing

PROCEEDINGS AT ANNUAL CONFERENCE AT TORQUAY

(*Continued from* METAL INDUSTRY, 16 *May* 1958)

AT the first technical session of the Annual Conference of the Institute of Metal Finishing, which was held recently at Torquay, the third Paper to be presented dealt with two proprietary solutions and the effect of bath life on plated castings of bright nickel. An abstract of this Paper is published below, together with some of the major contributions to the discussion. Abstracts of other Papers presented at the conference, and further extracts from the discussions, will appear later.

The Properties of Bright Nickel Electrodeposits in Relation to the Period of Service of the Plating Bath

By J. EDWARDS, Ph.D., B.Sc. and V. E. CARTER

TWO proprietary bright nickel solutions were operated under simulated production conditions, properties of the deposits and of the solutions being measured periodically. No particular difficulty was experienced in operating each bath for about 1,200 Ah/gal., after which the solutions began to produce unacceptable deposits.

Important properties affected by ageing of the solution were brightness, internal stress and ductility. Stress tended to increase and ductility to decrease. The brightness range of one solution contracted with time, and the solution was deemed to require purifying when it became impossible to maintain brightness all over the plated articles. Purification of the other solution was considered to be necessary when the deposit became excessively brittle. Drag-out and other solution losses were small; had they been larger, the solutions would probably have produced satisfactory plate for a longer period.

Many properties were unaffected by ageing, e.g. throwing power, microhardness, adhesion. It was also found that the accuracy of two methods of determining nickel thickness—B.N.F. jet test and thermoelectric method—was unrelated to the length of service of the plating bath.

The changes in properties appear to be due to organic impurities in the solution, arising more probably from decomposition of addition agents than from external sources. Consideration of the factors determining the concentration of impurities suggests that it would be more economical in practice to maintain a tolerated level of impurity than to remove all the impurity periodically.

Atmospheric exposure tests at industrial and marine sites, and accelerated tests in a moist atmosphere containing sulphur dioxide, showed no tendency for the corrosion resistance of organic bright nickel+chrome coatings to vary with increasing length of service of the nickel bath. The pattern of attack was very similar in atmospheric and accelerated tests. Crazing of the chromium occurred to about the same extent in an industrial atmosphere as in the sulphur dioxide test. Extended salt spray tests had almost no effect on the coatings.

(*Trans. Inst. Met. Finishing*, 1958, **35**, *Advance Copy No.* 3.)

DISCUSSION

E. A. Ollard (Atlas Plating Works):
That the solutions do change with time has been shown by Dr. Edwards, and also that this change is due to the accumulation of a certain substance in the solution, though he has not been able to state exactly what it is or where it comes from.

Dr. Edwards says, in point of fact, that it seems to be a function of the working time and that these substances are produced by an electrochemical reaction in the cathode.

But there is another possibility: that they might be produced, at any rate in part, by some electrochemical reaction at the anodes. The average plater looks upon anodes as something he has an awful job to get. He has to pay through the nose for them, and when he has hung them in the bath he can forget all about them. He sometimes forgets so thoroughly that he finds when he pulls an anode up that it is hot inside.

On certain surfaces especially, when something like this happens, there may be a much higher oxygen over-voltage at the anode than was anticipated. In most of these solutions there is chloride, so a certain amount of chlorine may be liberated. One can often smell it. There may be some reaction of addition agents from the anodes, and it is to be hoped some of the people who are concerned with supplying anodes may consider this and look into the problem to see whether in certain circumstances the anodic reaction can upset any of these addition agents.

U. F. Marx (Wilmot Breeden Ltd.):
In his attempt to draw up, as it were, conclusions as to where the addition agents go, Dr. Edwards may have overlooked one source of loss, and that is insoluble breakdown products which come out on his filters. Has he ever looked at his filters when they have clogged up? I would not like to say how much can come out with filters, but I have an indication that there might be quite a lot. It would tend to upset his mathematics, and also there is a certain amount of brittle product which tends to be incorporated.

As to the point on organic impurities in the solution, they do arise in the solution, because, whatever the solution, wherever it comes from, whether in the shop or in the laboratory, when it has been worked to an equivalent degree the same spectrum of the impurities is found as Dr. Edwards found.

It has not been possible to isolate that to the breakdown products, but a pretty good idea has been obtained of what the spectrum looks like, and it is always the same. If it were some extraneous matter, the dust in one place is never the same as the dust in another place, and the spectrum itself would look different.

J. W. Oswald (Fescol Ltd.):
It is a step forward for the supply houses to allow their solutions to be investigated in this way, but it is impossible to discuss the degradation products and their possible effects without knowing exactly what chemicals have been used.

Has Dr. Edwards considered the possibility of contamination from his vat linings? It was rather significant that with the SG solution they went up to 46,000 Ah in a polythene-lined tank and got good deposits. They did another 3,900 Ah in a rubber-lined vat and started getting trouble. The permanent cathode baths were also in rubber-lined vats, and there was difficulty there. In these permanent cathode vats the ratio of in^2 of vat lining per gal. of solution was much higher than in the ordinary plating vats. It is quite well known for accelerated action upon rubber lining to give very queer effects. These effects are apparent, even after quite long periods of use, when they do not die away at all quickly. Has this possibility been suggested?

Why was the peculiar loading chosen for the hardness reading? It seems to be unnecessarily low for the hardnesses recorded and, taking the ordinary B.S. specification No. 427 for hardness, a loading of 5 kg. could have been used for this hardness of 400 to 600, with a thickness of 0·0075 to 0·009. Edwards' variations were probably of that order, so why was the standard load not used?

D. E. Weimer (M. L. Alkan Ltd.):
Could the results, as Ollard said, be

due to different anode current densities being used in the two different set-ups, or could it be due to a different rating of breakdown with the addition agents because of the different current densities being used in the two experiments?

Suppose current density and rate of breakdown were plotted, the result might be a rather exaggerated curve, but in the case of the permanent cathode experiments might we not be working in a different range? In the case of the over-rider experiments, a range might be worked which lies only in the centre portion of the curve. Although the effect of the current density may be the same, there may be less breakdown at the lower current density end, because the relationship of breakdown to current density is not linear.

S. H. Melbourne (G.K.N. Group Research Laboratory):

The more these modern solutions come up, the more they seem to smack of black magic. Is it 100 per cent security on the part of the supply houses that explains their reticence, or are they all that clear themselves what actually makes up the solutions?

Dr. Edwards says that levelling power determinations would clearly be valuable for some solutions, but methods employing metallographic procedures would not be feasible in most plating shops. There are, however, as most people know, other ways of determining levelling, though probably not quite so fundamental and accurate as are Dr. Edwards' methods. One of the more convenient methods, and also a direct reading method, is the analysis of surface profile by the use of a gauging method. Probably the most accurate instrument is the Talysurf, which has been used for surfaces in plating. The high degree of skill required in using it, particularly down irregular surfaces, makes it impracticable for the plating shop, although it is useful for the testing laboratory. There are other instruments working on similar principles, such as the profile tester, which are relatively inexpensive and easier to use. They have the advantage that, being directly applicable to the surface, the checks can be done on the components themselves in a non-destructive manner.

The results are not strictly comparable with those of Dr. Edwards, but a good system of quality control could be set up by a person in a responsible position deciding from appearance or other effects the type of smoothness wanted. The whole thing could be done by an instrument of the type mentioned, and that would achieve some advance in controlling the smoothness of deposits.

J. Dixon (M. L. Alkan Ltd.):

Referring to experience with both G. and S.G. solutions, in operating a solution something like 160,000 amp. a day, a gradual fall-off occurs, particularly in ductility and brightness. It can be recovered up to a point by further additions of brightener. A test for brightener has been used which, though not scientific, gave a good indication of the efficiency of the brightener content. This was a sodium formate estimation. After a return to 6 oz/gal. sodium formate, the brightener seemed to be working perfectly well. This could gradually be built up to about 8 oz/gal., and at this stage carbon treatment had to be carried out on the solution.

After the carbon treatment, the sodium formate figure went down to 6 again.

It is not suggested that carbon takes out sodium formate, but it removes something that is returned in the sodium formate estimation.

When showing people round the plant, a regular demonstration was to take off a strip of steel about 1 in. wide and 15 in. long, bend it at right angles, and twist it up to a complete spiral. On applying the standard routine maintenance, I was never let down. It was always possible to show that a controlled deposit did not crack or come off.

A procedure had to be adopted over six weeks of complete filtration through carbon, up to the storage tanks, and back down through the filters to the plating tank, the filter process being backed with fresh carbon when the solution went up, and again when the solution came down. In this way, the sodium formate figure could be kept within the range of 6 to 8. If it got up to 8, trouble began to occur. Solubility came in and the brightness went off. Further addition of brightener did not make any difference to the solution, and at 8 the carbon treatment was introduced. That was 160,000 amp. a day. It took about six weeks to get up to that figure.

This was plating steel, copper, brass, bronzes, and so on, and for the best adhesion of deposits a *p*H of 3·8 was run. This involved considerable ion build-up in the solution, and after six weeks it was necessary to do a peroxide treatment of the solution as well.

Mr. Newman (W. Canning and Co. Ltd.):

Dr. Edwards' tests were conducted on what might now be called fairly early bright levelling solutions, and some of the recent improvements in brightener for plating have taken cognizance of the comments he has made concerning the ability to filter through carbon continuously without removing too much of the addition agents. That is certainly a very attractive way of purifying the solution and keeping it consistently pure. In practice, continuous carbon treatment maintains both the physical properties, ductility and internal stress, at pretty consistent and good valuations.

One slight difference found with Dr. Edwards' work on the permanent cathode bath is that in our tests we use separate brightness and combined brightness in the complete bath, and glass tanks are used in order to eliminate any chance of impurity from organic materials, such as rubber linings. The rate of fall of the physical properties or the rate of deterioration is less in the glass tank than Dr. Edwards found in the rubber-lined tank. Therefore, it would appear that rubber linings can, in certain cases, although they are well leached and quite old, still be harmful. Nevertheless, they are very widely used and generally very satisfactory.

Concerning corrosion resistance, recent work has shown the great importance of the over coat chromium deposit on the corrosion resistance, and Dr. Edwards' findings are not at all mysterious. The change in the physical properties of the nickel deposit has a very minor influence on the corrosion picture as compared with the crack and pore pattern of the final chromium layer which is the overriding factor in the corrosion pattern.

Dr. S. Wernick (Consultant):

The main point which comes out of this Paper is that ageing affects neither throwing power nor corrosion resistance in the deposit. It matters very little what are the properties, but those two points are absolutely essential. It does, however, seem to conflict with the generally accepted thought that when stress gets out of hand in any bright nickel deposit, it will affect corrosion resistance.

Seeing that the general upheaval that usually occurs in operating bright nickels results, when additions are added, in stresses and ductility jumping up and down, why not have these addition agents added continuously throughout the life of the bath?

AUTHOR'S REPLY

Dr. J. Edwards: The dangers of using rubbers containing materials which are harmful are well known. All that could be done was done to ensure that these rubber linings were not to be included in that category. Initially, polythene linings were tried for a large vat, but we ran into difficulties with cracked linings, and abandoned them. It is probably true that glass tanks should have been used where they are practicable for the smaller permanent cathode baths.

It is probably very true that addition agents are broken down at the anode at least as much as at the cathode.

Marx referred to losses of impurity by insoluble material coming out on the filter. This is often observed in commercial practice, though not in our own work, although some impurity may be lost in that way. No doubt some is lost by complete decomposition into carbon dioxide or other oxides, but these are relatively small losses, one assumes, and by comparing the practical curve for the increase in impurity in the S.G. bath with the predicted curve from losses by drag-out, and so on, one could calculate the amount of material which is incorporated in the deposit or lost by complete decomposition.

Weimer's comments on the failure of the permanent cathode bath to behave exactly as the pilot plant behaves are rather interesting. Different anode current densities could affect the result, but the chief concern was not about the failure of the permanent cathode bath to produce deterioration exactly matched in rate with that of the pilot plant bath. The main thing was the fluctuation in properties which was attributed to the fact that the bath was operated for a considerable time virtually without attention; that is, without actually plating a specimen other than the permanent cathode in order to see how things were getting along. This is the major difficulty, although no doubt if more attention was given to the matter cathode baths could be operated under better conditions.

Dixon's remarks about his experiences, particularly his use of a *p*H of 3·8, are surprising. In our experience with S.G., that is too low.

Newman asked for comment on the effect of the top coat of chromium. This is hardly the place to do so, although it has been known for a long time that thicker deposits of chromium can be applied free from cracks and with full brightness by using increased temperature and current density.

It has often been claimed, and it seems reasonable, that the use of these deposits leads to better corrosion resistance. At a time of severe nickel shortage, six or seven years ago, people were urged to take advantage of this fact, and the reply generally was that the use of longer times on chromium plating, with higher current densities requiring better contacts and more accurately produced equipment,

rectifiers, and motor generators, precluded the adoption of this method. Interest is now reviving following some work in America, and further work is being undertaken in this country. It is quite on the cards that rather thicker deposits, approaching 0·0001 in. chromium, will be used as a decorative top coating for nickel.

Dr. Wernick commented that our results conflicted to some extent with the general idea that stress getting out of hand affects corrosion resistance. It is perfectly true that if the stress gets too high in relation to the ductility, cracking of the nickel will occur. There is no evidence, however, that the stress has any effect unless that stage is reached. Even cracking of the chromium, which was observed in these tests of something like 50 per cent, not on the over-riders, was not related to the stress in the nickel deposit nor to the age of the nickel solutions. The occurrence of this cracking seems to be entirely random. It was assumed that the operations were carried out with the thickness conditions of chromium deposits practically on the borderline of crazing of the chromium.

It was remarkable that in the sulphur dioxide tests carried out, the proportion of over-riders which showed crazing chromium after 96 hr. was almost exactly the same as the proportion showing crazing in exposure at Euston in a severe industrial atmosphere with conditions practically as bad as this in SO_2. The crazing which occurred at Hayling Island was very much less, though it increased with time after the one-year exposure tests reported in the Paper.

(To be continued)

Hard Nickel Electroforms

RESISTANCE to abrasion and impact of micrograin nickel, developed by Metachemical Processes Ltd., of Crawley, is unusually high, better than that of softer types of nickel, nickel deposited from solutions containing organic addition agents, or stainless steel; the material is also hard but flexible.

Electroforms of micrograin nickel are now being proved on the leading edges of aircraft propellers, where they guard the delicate de-icer elements against rupture due to impact with hail, or stones during landing or take-off. Results show that grain size can be so restricted that from the same electrolyte, under the same conditions, nickel with a hardness controllable between 120 and 800 Vickers pyramid number can be obtained.

Tests conducted on a number of Viscount propeller blades show the advantages of protecting the de-icers with a micrograin nickel electroform. While propeller tips were travelling at supersonic speed, batches of pebbles and rocks were sent down a chute, directed at the centre half of each propeller. Four different sizes were used, each taking about 2 to 3 sec. to go through. After the cumulative effects of all four runs, the electroform had been dented, but the de-icer elements embedded in the rubber still functioned; they had been knocked out after the second run in propellers with protective sheaths of stainless steel of equal weight.

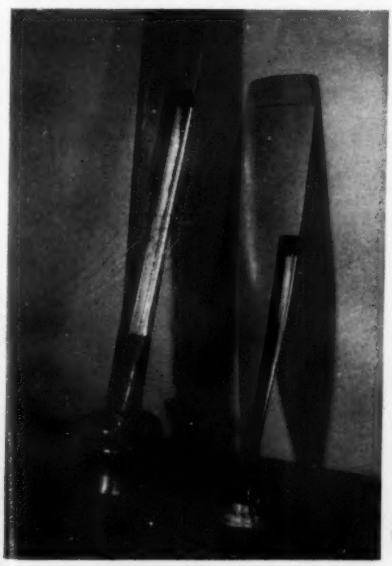
The superior properties of the nickel electroform are believed to stem from the very fine grain size deposited electrolytically. Although a standard nickel sulphate bath at conventional *p*H and temperature is used—without organic addition agents—grain size is so minute that to date no method of etching the deposit for micrographic analysis has been found. The fine grain is due to the characteristics of the electrically conductive plastics sheet on which the nickel is deposited.

To make a micrograin nickel electroform, a master mandrel of metal is first prepared, by casting from the contours of the propeller, wing, or other surface to be protected. An electrically conductive plastics coating, several mils thick, is then applied. After a flash coating of copper has been deposited, the unit is immersed in the nickel plating solution, and left until the desired thickness has built up. The propeller protectors come out "right" naturally, i.e. with a heavier thickness (about 0·025 in.) at the leading edge, tapering off to 7 mils at the trailing edge.

In this material, the finished electroform is under compressive stress, whereas most electrolytic nickel deposits show tensile stress. In fact, the compressive stresses set up are so noticeable that care must be taken to prevent cutting of the masking tape at the trailing edge, which would allow solution to enter between the mandrel and the plastics interlining, spoiling the piece.

Brinell hardness of the new type of nickel is up to 600, yet it may be bent easily, without fear of cracking. Therefore, even shapes with re-entrant surfaces may be plated on the mandrel, removed, then closely fitted to the finished product. The ID circular intake cowl of a jet engine, tapering toward the inside, is one such application.

At the moment, principal applications are in the aircraft industry, though other applications will, no doubt, come along. Ships' propellers, for example, may be protected against cavitational erosion, and other applications suggest themselves.



Left—Micrograin nickel electroform on two types of propeller blade

Right—Micrograin nickel electroform obtained by plating hard nickel on a plastics-coated mandrel

Automatic Plating for Cycle Components

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Overall dimensions are 108 ft. long by 12 ft. wide over tanks 13 ft. high. Output of this machine, which has three tracks of work continuously passing through, is 180 racks of work per hr. Each rack is 12 in. by 36 in., a convenient size for handling, and holds work with an effective surface area of over 2 ft^2.

The plating specification called for a combined deposit of copper, nickel and chromium. A thickness of 0·001 in. copper will be deposited in a bright cyanide copper tank with a capacity of 7,300 gal., and provision has been made to off-load those racks of work which require buffing before bright nickel plating. Subsequent additional cleaning processes are included to remove buffing composition before the racks enter the bright nickel tank, which has a capacity of 5,000 gal. The average nickel deposit will be 0·0005 in. and the solution used an air-agitated Efco-Udylite solution.

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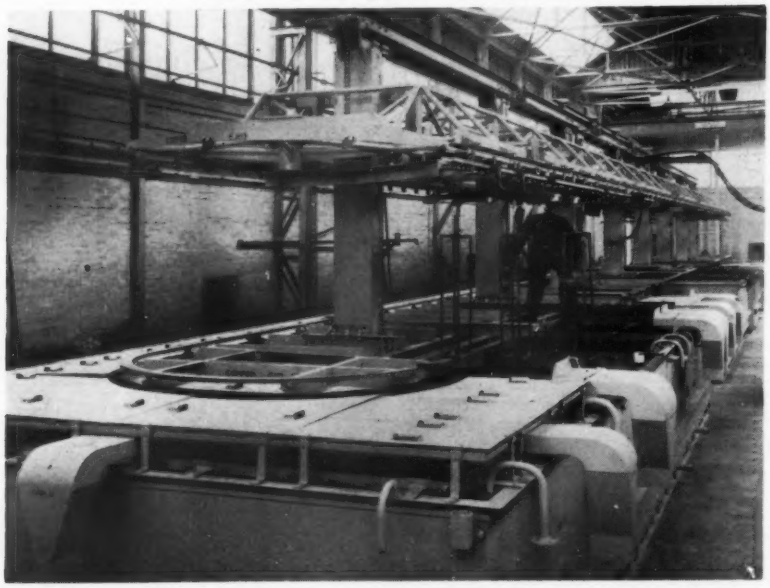

The automatic bright nickel plating machine showing the copper plating section in the foreground with the lifting frame and transfer mechanism in the raised position and three plating racks about to be transferred

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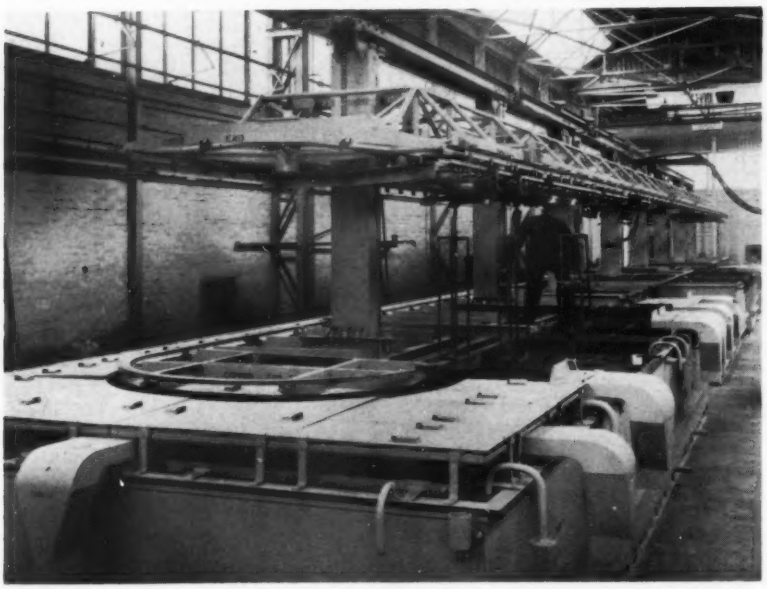

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successful as a means of preventing weld-spatter adhesion, and it has also been used with great success in zinc alloy and aluminium die-casting.

A Take-over

It is reported that **Armour Chemical Industries Limited** has taken over the business of the Chemical Division and The Armour Laboratories, previously part of Armour and Company Ltd.

Sima at Achema

A strong team of members of the **Scientific Instrument Manufacturers' Association of Great Britain** forms an important part of the considerable British participation in this year's European Exhibition and Congress of Chemical Engineering, being held next week at Frankfurt-am-Main, Western Germany. Outstanding among the many remarkable Achema exhibits are several United Kingdom electronic, nucleonic and optical developments which are not available from other sources and which embody unique features which, it is said, are not yet equalled in other instruments made in Europe or America.

Among the principal Sima exhibitors are the following firms:—Baird and Tatlock (London) Ltd.; C. Baker of Holborn Ltd.; Dawe Instruments Ltd.; Evans Electroselenium Ltd.; A. Gallenkamp and Co. Ltd.; Hilger and Watts Ltd.; and Stanton Instruments Ltd.

A Golf Meeting

The Spring meeting of the **National Association of Non-Ferrous Metal Merchants' Golfing Society** was held at the St. George's Hill Golf Club, Weybridge, on Wednesday of last week, and in the morning a Stapleford Competition for the President's Prize was played with the following results:—Winner: Mr. George Holloway; runner-up, Mr. G. Wolff; and third, Mr. A. E. Parker. Hidden prizes were won by Mr. H. T. Viney and Mr. J. R. Lee.

In the afternoon, a Greensome Competition was played, which was won by Mr. E. Lisle, partnered by Mr. G. R. Lee, and the runners-up were Mr. J. R. Lee and Mr. A. E. Parker.

Subsidies for U.S. Metals

Recent news from Washington states that the Eisenhower Administration has submitted its proposals to Congress to pay subsidies to United States producers of copper, lead, zinc, fluorspar and tungsten. The proposals were contained in a letter and proposed legislation sent by Mr. Fred A. Seaton, the Secretary of the Interior, to Mr. Richard M. Nixon, the President of the United States Senate.

The proposed stabilization prices and the annual amounts of domestic production on which the subsidies would be paid were as follows:—Copper: 27½ cents per lb. delivered Connecticut Valley, 1,000,000 tons; lead: 14½ cents per lb., New York delivery, 350,000 tons; zinc: 12½ cents per lb., East St. Louis delivery, 550,000 tons; fluorspar, acid grade: 48 dollars per short ton, delivery Rosiclare, Illinois, 180,000 short tons; tungsten trioxide: 36 dollars per short ton unit, f.o.b. shipping point, 375,000 short ton units.

The Secretary of the Interior would be authorized to establish quarterly limitations on the total amounts of each material on which the stabilization payments would be made. The stabilization payments would be made to any producer during one quarter, provided that the producer did not sell more than 2,500 tons of copper, 1,250 tons of lead, 1,250 tons of zinc, 1,250 tons of fluorspar, and 3,000 short ton units of tungsten.

As to tungsten, the Secretary would not buy more than 15,000 short ton units per quarter from production originating in any one mining district.

Lead Development

The fifth annual general meeting of the **Lead Development Association** is to be held on June 16 next. The annual report shows that there are now eighteen corporate members of the association.

A Company History

Under the title of "Stepping Out with Progress," **The Morgan Crucible Company Ltd.** has published an explanatory leaflet which describes the history and development of the company in a shortened form. A number of excellent photographs of the company's factories and works are given, together with some illustrations of their products, and also a complete list of subsidiary and assocated companies.

Storage Units

A novel design of storage unit which allows steel drums to be stacked up to five tiers high by means of a fork lift truck has been introduced by the South Wales firm of **Powell and Company.** Each drum is securely cradled and the forks are always safely positioned under the load during stacking operations.

These units are of tubular steel and can easily be carried by one man. Each unit holds two drums, and no permanent fixtures are required to enable drums to be stored neatly and safely either in or out of doors. There is also, it is claimed, no danger from slipping.

Aluminium in Norway

Plans for the second construction stage in the expansion of the State-controlled aluminium plant at Aardal, to cost about £20 million, have been approved by the Norwegian Parliament. Including the first construction stage, already completed, the plant expansion programme is expected to cost about £39·65 million.

The first stage increased the capacity of the plant by 32,000 tons annually. Another 32,000 tons will be added when the second expansion phase is finished. The annual output should then be approximately 100,000 tons a year, consuming about one-twelfth of the hydro-electric power produced in Norway.

Sand Conveying

New plant incorporating a six-stage axial flow fan has increased pneumatic sand conveying to the core moulding shop at the Farrington Foundries of Leyland Motors Ltd., from two to five tons per hour. The conveying system was previously powered by a large centrifugal fan absorbing 20 h.p. Its delivery capacity of two tons of finished sand per hour proved inadequate for present production. The new unit consists of six single-stage 19 in. Aerofoil fans, absorbing 34·1 h.p. Air moved is 9,000 ft^3/min. at 16 in. water gauge.

This pneumatic sand conveying plant is described in the latest issue of "Fanfare," the house magazine of **Woods of Colchester Limited.** The description is accompanied by several interesting illustrations.

An Amalgamation

It has been announced by **Steele and Cowlishaw Ltd.,** of Stoke-on-Trent, that an amalgamation of interests has been arranged between that company and **Baker Perkins Ltd.,** of Peterborough. The future policy of the combined companies will be to extend and develop still further their combined range of machinery and equipment for mixing, grinding, blending, sieving and dispersion, etc., to meet the present and changing needs of the industries they serve.

Project Engineer

An appointment recently announced by the **Hymatic Engineering Company Ltd.** is that of Mr. Ian Murdoch, who is to be project engineer to the company. Mr. Murdoch was previously with the Tropicalisation and Packing Company, and earlier with Smiths Aircraft Instruments and the de Havilland Aircraft Company.

Malayan Tin Mines Close

Recent advices from Kuala Lumpur state that more Malayan tin mines and dredges are being compelled to close down due, it is said, to the international tin restriction scheme. The reports state that up to date 27 mines and 12 dredges have ceased operations, and it is expected that, unless there is an increase in the output quota for the next quarter, further closures will take place.

A World Tour

Returning from a 54,000-mile journey round the world, Mr. Reg. Jackson-Cox, technical liaison manager of the **Slip Group of Companies,** manufacturers of combustion improving fuel oil additives and corrosion treatments, has, in eleven weeks, visited 16 countries and the five continents, passing on the latest technical information on the group's products and co-ordinating the selling policies of Slip associate companies, subsidiaries, agents, and distributors.

Of the purpose of his trip, Mr. Jackson-Cox says: "If British companies are to take advantage of expanding markets abroad, they must be prepared to back their sales machinery with the fullest technical advice. In my particular business, we find that people lack precise knowledge about the application of chemical treatments to distillate and residual fuels, especially where they are derived from different crudes. My job was to try to put this right."

Results of this marathon journey include the following achievements: (a) Many new accounts have been established. New distributors have been appointed in Canada, British Columbia and Singapore. (b) Mr. Jackson-Cox gave a number of lectures during his tour, including one to a special meeting of the Japanese Transport Association of Osaka. Following this meeting, 100 vehicles of the Osaka Transport Commission are now using Slip products for a 12-month test period. (c) In the Far East, the use of oil in the generating of electrical power is causing problems of corrosion. The Municipal Pasirpajang Power Station in Singapore has now adopted the Slip method of combating this. The State Power Corporation of Greece, the Kansai Power Station near Osaka, the Canadian Pacific Railway, and the China Light and

Power Company (Hong Kong) are all conducting tests with a view to following suit.

Summarizing his impressions, Mr. Jackson-Cox states: "Our greatest potential markets are Canada, South Africa, and Australia. But wherever we sell, we must support our campaigns with facts and figures in appropriate languages."

Engineering Scholarships

It has been announced by the Civil Engineering Scholarship Trust that some ten or twelve scholarships in civil engineering should be available for the academic year of 1958-59, and a larger number in future years. These scholarships are specifically designed to help youths who are unable to get the full benefit of State and local authority scholarships because of the operation of a means test.

Dependent on the financial circumstances of the applicant, these scholarships will not normally exceed £400 annually and will be tenable for three or four years according to the length of the course.

U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange official warehouses at the end of last week totalled 18,463 tons, comprising London 5,934; Liverpool, 11,339; and Hull, 1,190 tons.

Copper stocks totalled 16,807 tons, and comprised London 10,609, Liverpool 5,808, Birmingham 215, and Swansea 175 tons.

Staff Appointment

It has been announced by **British Oxygen Gases Ltd.** that Mr. J. E. Clark has been appointed manager of the Midlands district for the company in succession to Mr. J. G. Williams, who has retired from the service of the company after 46 years' service.

Morgan Crusilite

A new publication has just been put out by the **Morgan Crucible Company Ltd.** under the title of "Crusilite Electric Furnace Element." The advantages of Crusilite are explained in this leaflet, together with details of its operation, also charts and diagrams.

Annual Meeting

Members of the **National Association of Non-Ferrous Scrap Metal Merchants** are reminded that the seventeenth annual general meeting of the association is to be held at Grosvenor House, Park Lane, London, on Wednesday, June 11 next, at 11 a.m., when the general business of the association will be transacted, the new President installed, six members of the council elected, and the election of an honorary treasurer and of a vice-president carried out.

Soviet Zinc Process

According to Tass, the Soviet news agency, the world's first electrolytic cell for the continuous production of zinc has been designed by the Kazakh Chemistry Institute in Alma Ata. The conventional method of producing zinc from zinc sulphate solutions in electrolytic cells with stationary cathodes has been replaced, it is claimed, by one in which the current density has been increased several times from the usual density of 500 amp/m² of cathode surface. The stationary cathodes have been replaced by revolving ones, so that with the new type of cell zinc is obtained in a continuous ribbon from 0·2 to 0·5 mm. in thickness.

One of the advantages claimed for this new method is that it is possible to conduct the process in airtight conditions, thus removing health hazards, and the new method will make it possible to automate zinc production entirely. Tests on an industrial scale are already under way in Kazakhstan and in the Ukraine.

Non-Ferrous Club

On Wednesday next, June 4, **The Non-Ferrous Club** will hold its monthly luncheon meeting in the Warwick and Dudley rooms of the Queen's Hotel, Birmingham, at 12.15 p.m. The guest speaker on this occasion will be Mr. William MacQuitty, one of the senior producers of the J. R. Rank Productions Ltd., who will talk about the film industry in general.

Lead Stockpiling in U.S.

According to the latest news from Washington, the General Services Administration has now sent out its last invitation for offers of lead for the stockpile. At the same time, the Office of Defense Mobilization has said that this would be the end of Government buying for the stockpile of this metal. The agency recently ended its purchases of zinc.

Visiting Soviet Russia

At the invitation of the Soviet Government's Scientific and Technical Committee, Mr. Robert Asquith and Mr. Francis Field, heads of William Asquith Ltd. and Fielding and Platt Ltd., respectively, have arrived in Moscow on a visit to Russia.

Anti-Dumping Law

It is reported from Washington that the U.S. Senate has passed a Bill providing that a tie vote in the six-man Tariff Commission in an anti-dumping case shall be construed as an affirmative ruling that dumping is involved. The Anti-Dumping Law requires the Treasury to assess higher duties when a foreign country is found to be dumping products in the United States. The Senate also voted a provision under which failure by the Tariff Commission to act within three months after a complaint about certain imports would result in an automatic finding of injury to domestic producers and call for imposition of duties.

Both provisions were passed as an amendment to a Bill designed to provide greater certainty, speed and efficiency in enforcement of the Anti-Dumping Law. The Bill now goes back to the House.

In another action, the Senate returned to the House a Bill extending for one year, from June 30, the present suspension of duties on metal scrap. A Senate amendment to the Bill excludes from the exemption, non-ferrous metal in pig, ingot or billet form which is commercially usable in direct manufacturing without modification.

The Metric System

Set up by The British Association, a Study Group, under the chairmanship of Sir Hugh Beaver, is to carry out investigations into the full consequences of a change-over to the metric system in this country. The actual work of the group is to "report on the practicability, implications, consequences both international and domestic, and the cost of a change-over to the metric system or the decimalization of weights, measures and coinage by the United Kingdom." Interim reports on the progress of the investigation are to be submitted at quarterly intervals to the council of the association, and a full report in about 18 months' time.

In addition to Sir Hugh Beaver, the members of the group are: Dr. A. H. Hughes (deputy chairman and assistant managing director, Arthur Guinness, Son and Co.), Dr. R. Beeching (director of Imperial Chemical Industries), Mr. M. G. Bennett (general treasurer, British Association), Professor C. F. Carter (Professor of Applied Economics, Queen's University, Belfast), Mr. Hugh Conway (joint managing director, Short Brothers and Harland Ltd.), Mr. A. C. Hartley (consulting engineer), Lord Simon of Wythenshawe, Mr. F. S. Walker (chairman of Lever Brothers, Port Sunlight, Ltd.), and Mr. C. P. Jones (Rolls-Royce Ltd.).

Obituary

Mr. A. C. Smith

IT is with much regret that we have to record the death, at the age of 57, of Mr. Arthur Cecil Smith, a director of the Halford Polishing and Plating Company Limited, Smethwick, Birmingham. Mr. Smith, who had been ill for some time, was connected also with associated companies in Tividale and Smethwick.

Metal Market News

ON the whole, markets were steady in last week's trading, shortened by the fact that the Exchange closed its doors at midday on Friday so that there was no afternoon session on that day. As will be seen from the notes on copper below, there was a good deal to encourage an advance in this metal, for the news was mostly favourable, but actually the market seemed a little half-hearted in its response to favourable factors. Sessions on Wall Street have been pretty brisk and the tendency firm on the whole, while the Stock Exchange here also made a reasonably good showing. While steel production in the States is still low, and many other industries running well below their normal activity, there can be little doubt that the recession in America has, to a considerable extent, flattened out, so that many people feel that we have seen the worst. At the same time, nobody is prepared to say how long it will be before an upturn in activity occurs. In regard to copper, it has been suggested that there will be an improvement in the last quarter of this year, but there is no guarantee of this, and some people hold the view that it may be the autumn of next year before the tide really turns. So far as the U.K. is concerned, the indications are that activity is diminishing, and one is inclined to the view that the effects of the American recession are now being felt here. Much labour unrest is still in evidence, and strikes at various centres were in existence last week. Probably because, as just mentioned, there are signs of activity slowing down, a decision was reached to reduce the Bank Rate by ½ per cent last Thursday to 5½ per cent, and it is by no means impossible that in the course of the coming weeks we may see a further cut to 5 per cent. From America came the report that the Kaiser Aluminium Corporation was reducing activity by 10 per cent. In view of reports that demand on the light alloy side of the industry was diminishing, this news was not altogether surprising.

In copper, the week started off with a reduction of no less than 1,125 tons to 16,582 tons in L.M.E. warehouse stocks, while on Wednesday the market heard that the Chuquicamata strike had at long last been settled, with the prospect that the men would return on the following day and would use their best efforts to make up the lost tonnage, which was estimated at some 30,000 metric tons. Then came the announcement of a 20 per cent cut by Phelps Dodge in Arizona, which means a reduction of about 3,600 tons per month. Finally, last Friday the market heard of an advance of 25 points by the custom smelters to 24 cents, which puts this price within 1 cent of the producers' quotation at 25 cents. On the Commodity Exchange activity increased again last week and business, supposedly of a speculative nature, was at a high level. Just what the open position is on this market at the present time is a matter of guesswork, but some time ago it was estimated at 20,000 short tons, so presumably to-day it might well be twice as much—about 40,000 tons. So far there has not been any evidence of serious liquidation by holders of future positions in New York, but the time may come when operators will turn bearish and liquidate part, at any rate, of their holding. On the standard market last week some 8,250 tons changed hands, the close being £179 10s. 0d. cash and £182 three months.

Overall movement during the week included a low point of £177 for cash and £179 three months, so that the change in value was not by any means excessive. The Kerb market on Friday closed 10s. down, with sellers at £181 10s. 0d., and, all things considered, it cannot be said that buyers showed much enthusiasm. Above £180 there are undoubtedly a good many people ready to put out shorts on the market, and this keeps the advance in check. Tin lost 10s. both positions on a turnover of 1,025 tons, the close being £730 10s. 0d. for cash and £733 10s. 0d. for three months. About 3,600 tons of zinc changed hands, the only change in value being an advance of 5s. in August metal to £62. May closed at £61 7s. 6d. Lead was 10s. down for May, with no change in August.

Birmingham

At a recent meeting of the Regional Board for Industry it was reported that the slackening of business in the Midlands has not been great. Consumption of electricity by industrial firms showed a substantial rise over the corresponding period last year, said Mr. Stephen Burman, the deputy chairman. Latest figures for unemployment are 1·4 per cent, compared with the national average of 2 per cent. The labour dispute in the motor industry has, however, resulted in a serious loss of output, not only in the works but amongst the suppliers of components, and activity has been on a very reduced scale since production was resumed on Wednesday.

There is little change in the iron and steel position. Heavy plates continue an active market but are rather easier to obtain than they were at the beginning of the year. Re-rolling firms lack orders, especially for small bars and light sections. Deliveries of heavy joists and sections are slowing down, consistent with a reduced demand from constructional engineers, and unless there is an early improvement in the volume of business, conditions are likely to be even quieter in the second half of the year. Good business is being done in heavy castings for shipbuilding and rolling stock work. Trade in light iron castings is dull.

New York

The main feature of the past week was the intensified pressure on the lead price, which finally forced a half-cent decline in the price of domestic metal. The new lead price, at 11½ cents New York basis, was the lowest level since July, 1950. Cut-price foreign competition was the leading factor in the decline but, like previous cuts, the latest reduction failed to stimulate any noticeable consumer demand. Sales of U.S.-mined lead continued at the lowest level for several years.

The situation in zinc is similar to that in lead. U.S. stocks have been increasing sharply, imports have been large and underselling U.S. metals by ½ to ¾ cent per lb. The delay, and developing pessimism, regarding increased tariff duties on imported lead and zinc, and the vagueness of industry and dissatisfaction with the administration's mineral aid plan unveiled recently by Secretary of the Interior Fred A. Seaton, have given domestic producers little cause for encouragemen. Zinc demand was slow during the week at 10 cents per lb. East St. Louis for Prime Western.

Copper continued to show fair movement from custom smelters at 23¾, but remained slow in the producer sector at 25 cents. Imported copper products, particularly copper water tubing, forced domestic fabricators to lower the price of the product again for a total of 18 per cent in a week. Foreign copper water pipe has been selling in the U.S. at prices as much as 23 per cent under the similar American products. Mr. C. F. Mackie, President of Revere Copper and Brass Incorporated, a leading domestic fabricator, said: "The price reductions we have made bring our prices into closer relationship with the foreign products, although they are not justified by costs or earnings."

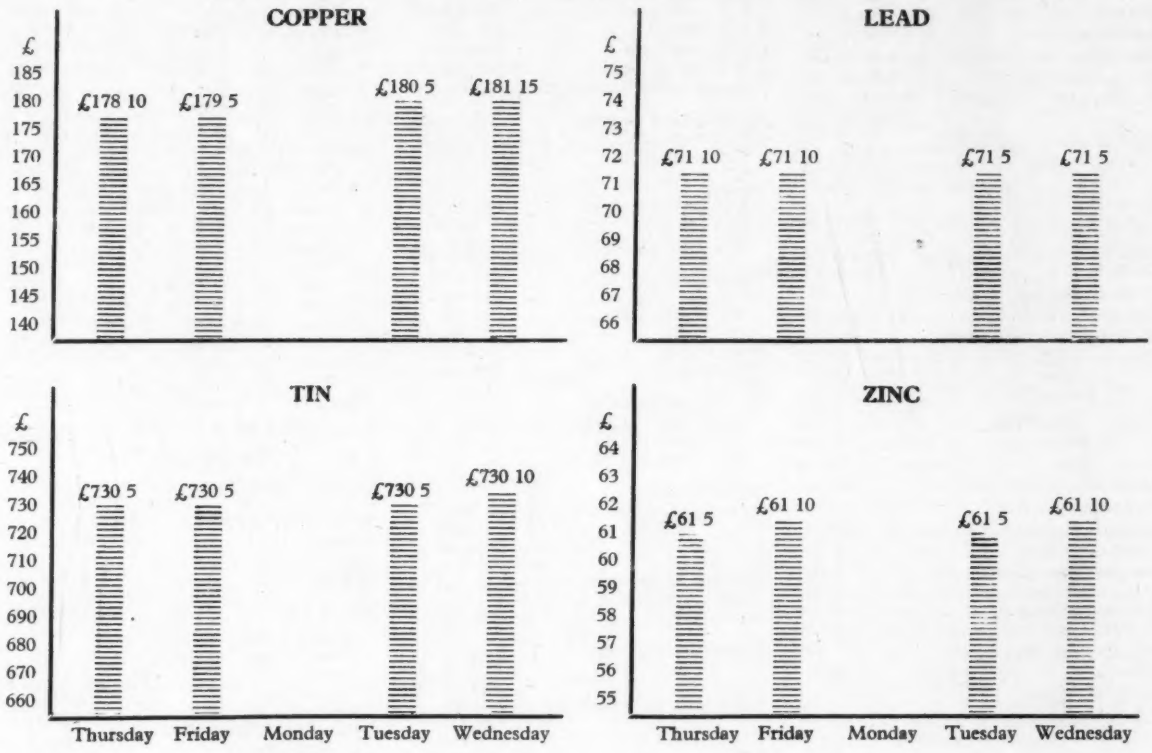
Tin moved somewhat erratically, with interest in the U.S. confined to dealers and smaller tinplaters. The volume of business done, however, was modest. Latterly, the tone was barely steady.

The Eisenhower Administration has submitted its proposals to Congress to pay subsidies to U.S. producers of copper, lead, zinc, fluorspar and tungsten.

The proposed stabilization prices and the annual amounts of domestic production on which the subsidies would be paid are set out on page 458 of this issue of METAL INDUSTRY.

METAL PRICE CHANGES

LONDON METAL EXCHANGE, Thursday 22 May 1958 to Wednesday 28 May 1958



OVERSEAS PRICES

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

	Belgium fr/kg ≏ £/ton	Canada c/lb ≏ £/ton	France fr/kg ≏ £/ton	Italy lire/kg ≏ £/ton	Switzerland fr/kg ≏ £/ton	United States c/lb ≏ £/ton
Aluminium		22.50 185 17 6	210 182 15	375 217 10		26.10 208 17 6
Antimony 99.0			195 169 12 6	430 249 10		29.00 232 0
Cadmium			1,400 1,218 0	2,550 1,479 0		155.00 1,240 0
Copper						
Crude						
Wire bars 99.9				375 217 10		
Electrolytic	25.25 184 10	24.25 200 7 6	230 200 2 6		2.30 192 7 6	25.00 200 0
Lead		11.00 90 17 6	110 95 15	178 103 5	.93 77 15	11 50 92 0
Magnesium						
Nickel		71.50 590 10		1,330 771 10	7.80 652 5	74.00 592 0
Tin	102.00 745 12 6		915 796 0	1,400 812 0	8.60 719 2 6	94.37 755 0
Zinc						
Prime western		10.00 82 12 6				10.00 80 0
High grade 99.95		10.60 87 10 0				
High grade 99.99		11.00 90 5				
Thermic			107.12 93 2 6			
Electrolytic			115.12 100 2 6	155 90 0	.82 68 10	11.25 90 0

NON-FERROUS METAL PRICES

(All prices quoted are those available at 12 noon 28/5/58)

PRIMARY METALS

		£	s.	d.
Aluminium Ingots	ton	180	0	0
Antimony 99·6%	„	197	0	0
Antimony Metal 99%	„	190	0	0
Antimony Oxide	„	180	0	0
Antimony Sulphide Lump	„	190	0	0
Antimony Sulphide Black Powder	„	205	0	0
Arsenic	„	400	0	0
Bismuth 99·95%	lb.		16	0
Cadmium 99·9%	„		10	0
Calcium	„	2	0	0
Cerium 99%	„	16	0	0
Chromium	„		6	11
Cobalt	„		16	0
Columbite	per unit		—	
Copper H.C. Electro	ton	181	15	0
Fire Refined 99·70%	„	180	0	0
Fire Refined 99·50%	„	179	0	0
Copper Sulphate	„	66	0	0
Germanium	grm.		—	
Gold	oz.	12	9	5½
Indium	„		10	0
Iridium	„	26	0	0
Lanthanum	grm.		15	0
Lead English	ton	71	5	0
Magnesium Ingots	lb.		2	5½
Notched Bar	„		2	10½
Powder Grade 4	„		6	3
Alloy Ingot, A8 or AZ91	„		2	8
Manganese Metal	ton	300	0	0
Mercury	flask	76	0	0
Molybdenum	lb.	1	10	0
Nickel	ton	600	0	0
F. Shot	lb.		5	5
F. Ingot	„		5	6
Osmium	oz.		nom.	
Osmiridium	„		nom.	
Palladium	„	7	10	0
Platinum	„	25	0	0
Rhodium	„	40	0	0
Ruthenium	„	16	0	0
Selenium	lb.		nom.	
Silicon 98%	ton		nom.	
Silver Spot Bars	oz.		6	4⅛
Tellurium	lb.		15	0
Tin	ton	730	10	0
***Zinc**				
Electrolytic	ton		—	
Min 99·99%	„		—	
Virgin Min 98%	„	61	13	9
Dust 95/97%	„	104	0	0
Dust 98/99%	„	110	0	0
Granulated 99+%	„	86	13	9
Granulated 99·99+%	„	99	8	9

**Duty and Carriage to customers' works for buyers' account.*

INGOT METALS

Aluminium Alloy (Virgin)	£	s.	d.
B.S. 1490 L.M.5 ton	210	0	0
B.S. 1490 L.M.6 „	202	0	0
B.S. 1490 L.M.7 „	216	0	0
B.S. 1490 L.M.8 „	203	0	0
B.S. 1490 L.M.9 „	203	0	0
B.S. 1490 L.M.10 „	221	0	0
B.S. 1490 L.M.11 „	215	0	0
B.S. 1490 L.M.12 „	223	0	0
B.S. 1490 L.M.13 „	216	0	0
B.S. 1490 L.M.14 „	224	0	0
B.S. 1490 L.M.15 „	210	0	0
B.S. 1490 L.M.16 „	206	0	0
B.S. 1490 L.M.18 „	203	0	0
B.S. 1490 L.M.22 „	210	0	0

		£	s.	d.
†**Aluminium Alloy (Secondary)**				
B.S. 1490 L.M.1	ton	154	10	0
B.S. 1490 L.M.2	„	161	10	0
B.S. 1490 L.M.4	„	183	0	0
B.S. 1490 L.M.6	„	204	0	0
†Average selling prices for March				
***Aluminium Bronze**				
BSS 1400 AB.1	ton	200	0	0
BSS 1400 AB.2	„		—	
***Brass**				
BSS 1400-B3 65/35	„	128	0	0
BSS 249	„		—	
BSS 1400-B6 85/15	„	170	0	0
***Gunmetal**				
R.C.H. 3/4% ton	ton		—	
(85/5/5/5)	„	153	0	0
(86/7/5/2)	„	162	0	0
(88/10/2/1)	„	212	0	0
(88/10/2/½)	„	222	0	0
Manganese Bronze				
BSS 1400 HTB1	„		—	
BSS 1400 HTB2	„		—	
BSS 1400 HTB3	„		—	
Nickel Silver				
Casting Quality 12%	„		nom.	
„ „ 16%	„		nom.	
„ „ 18%	„		nom.	
***Phosphor Bronze**				
2B8 guaranteed A.I.D. released	„	238	0	0
Phosphor Copper				
10%	„	212	0	0
15%	„	220	0	0
***Average prices for the last week-end.*				
Phosphor Tin				
5% ton			—	
Silicon Bronze				
BSS 1400-SB1	„		—	
Solder, soft, BSS 219				
Grade C Tinmans	„	344	6	0
Grade D Plumbers	„	278	6	0
Grade M	„	377	6	0
Solder, Brazing, BSS 1845				
Type 8 (Granulated)	lb.		—	
Type 9 „	„		—	
Zinc Alloys				
Mazak III	ton	92	13	9
Mazak V	„	96	13	9
Kayem	„	102	13	9
Kayem II	„	108	13	9
Sodium-Zinc	lb.		2	5

SEMI-FABRICATED PRODUCTS

Prices of all semi-fabricated products vary according to dimensions and quantities. The following are the basis prices for certain specific products.

Aluminium			£	s.	d.
Sheet	10	S.W.G. lb.		2	8
Sheet	18	S.W.G. „		2	10
Sheet	24	S.W.G. „		3	1
Strip	10	S.W.G. „		2	8
Strip	18	S.W.G. „		2	9
Strip	24	S.W.G. „		2	10½
Circles	22	S.W.G. „		3	2
Circles	18	S.W.G. „		3	1
Circles	12	S.W.G. „		3	0
Plate as rolled		„		2	7½
Sections		„		3	1½
Wire 10 S.W.G.		„		2	11
Tubes 1 in. o.d. 16 S.W.G.		„		4	0

Aluminium Alloys			£	s.	d.
BS1470. HS10W.		lb.			
Sheet	10	S.W.G. „		3	0½
Sheet	18	S.W.G. „		3	3
Sheet	24	S.W.G. „		3	10½
Strip	10	S.W.G. „		3	0½
Strip	18	S.W.G. „		3	2
Strip	24	S.W.G. „		3	10
BS1477 HP30M. Plate as rolled		„		2	10½
BS1470. HC15WP.					
Sheet	10	S.W.G. lb.		3	6½
Sheet	18	S.W.G. „		4	0½
Sheet	24	S.W.G. „		4	10½
Strip	10	S.W.G. „		3	9½
Strip	18	S.W.G. „		4	0½
Strip	24	S.W.G. „		4	8
BS1477. HPC15WP. Plate heat treated		„		3	5½
BS1475. HG10W. Wire	10	S.W.G. „		3	9½
BS1471. HT10WP. Tubes 1 in. o.d. 16 S.W.G.		„		4	11
BS1476. HE10WP. Sections		„		3	1
Beryllium Copper					
Strip		„	1	4	11
Rod		„	1	1	6
Wire		„	1	4	9
Brass Tubes		„		1	5⅜
Brazed Tubes		„		—	
Drawn Strip Sections		„		—	
Sheet		ton		—	
Strip		„		—	
Extruded Bar		lb.		1	8½
Extruded Bar (Pure Metal Basis)		„		—	
Condenser Plate (Yellow Metal)		ton	147	0	0
Condenser Plate (Naval Brass)		„	158	0	0
Wire		lb.		2	3⅛
Copper Tubes		lb.		1	8⅞
Sheet		ton	205	10	0
Strip		„	205	10	0
Plain Plates		„		—	
Locomotive Rods		„		—	
H.C. Wire		„	227	5	0
Cupro Nickel Tubes 70/30		lb.		3	2⅜
Lead Pipes (London)		ton	115	5	0
Sheets (London)		„	113	0	0
Tellurium Lead		„	£6 extra		
Nickel Silver Sheet and Strip 7%		„		3	3
Wire 10%		„		3	9½
Phosphor Bronze Wire		„		3	6⅛
Titanium (10,000 lb. lots) Billet 11″-4″		lb.	69/-		60/-
Wire ·315″-·036″		„	101/-		201/-
Sheet (4′/8′×2′) ·160″-·010″		„	100/-		158/-
Strip ·048″-·003″		„	100/-		350/-
Tube Representative gauge		„	320/-		
Extrusions		„	137/-		
Zinc Sheets, English destinations		ton	95	10	0
Strip		„	nom.		

Scrap Metal Prices

Merchants' average buying prices delivered, per ton, 27/5/58.

	£
Aluminium	
New Cuttings	143
Old Rolled	120
Segregated Turnings	90
Brass	
Cuttings	115
Rod Ends	112
Heavy Yellow	97
Light	92
Rolled	107
Collected Scrap	94
Turnings	106
Copper	
Wire	157
Firebox, cut up	157
Heavy	149
Light	144
Cuttings	157
Turnings	142
Braziery	123
Gunmetal	
Gear Wheels	152
Admiralty	152
Commercial	128
Turnings	123
Lead	
Scrap	64
Nickel	
Cuttings	—
Anodes	476
Phosphor Bronze	
Scrap	128
Turnings	123
Zinc	
Remelted	53
Cuttings	39
Old Zinc	30

The latest available scrap prices quoted on foreign markets are as follow. (The figures in brackets give the English equivalents in £1 per ton):—

West Germany (D-marks per 100 kilos):		
Used copper wire	(£156.12.6)	180
Heavy copper	(£152.5.0)	175
Light copper	(£130.10.0)	150
Heavy brass	(£100.0.0)	115
Light brass	(£69.12.6)	80
Soft lead scrap	(£57.10.0)	66
Zinc scrap	(£39.2.6)	41
Used aluminium unsorted	(£87.0.0)	100
France (francs per kilo):		
Copper	(£193.2.6)	222
Heavy copper	(£193.2.6)	222
Light brass	(£139.5.0)	160
Zinc castings	(£65.5.0)	75
Tin	(£565.10.0)	650
Aluminium pans (98½ per cent)	(£117.10.0)	135
Italy (lire per kilo):		
Aluminium soft sheet clippings (new)	(£188.10.0)	325
Aluminium copper alloy	(£101.10.0)	175
Lead, soft, first quality	(£84.2.6)	145
Lead, battery plates	(£49.7.6)	85
Copper, first grade	(£174.0.0)	300
Copper, second grade	(£162.10.0)	280
Bronze, first quality machinery	(£177.0.0)	305
Bronze, commercial gunmetal	(£148.0.0)	255
Brass, heavy	(£124.15.0)	215
Brass, light	(£113.2.6)	195
Brass, bar turnings	(£121.17.6	210
New zinc sheet clippings	(£55.2.6)	95
Old zinc	(£40.12.6)	70

Financial News

Glacier Metal Co. Ltd.

Dividend 11½ per cent year ended February 28, 1958 (same). Profit, after crediting £16,798 from special sales and £15,000 from stock contingency reserve, is £102,421 (£73,811), after tax of £126,597 (£110,406). To general reserve £30,000 (nil).

Hudson and Wright Ltd.

Net profit 1957 £52,829 (£66,997) and dividend 20 per cent (same). Fixed assets £174,696 (£128,792), current assets £519,597 (£534,149) and liabilities £162,549 (£148,361). Reserves £310,744 (£293,580), including future tax £45,750 (£56,000).

Gibbons (Dudley) Ltd.

Before tax of £179,129 (£265,763), profit for 1957 £349,225 (£517,761) and Ordinary dividend 15 per cent (same). Current assets £1,518,003 (£1,411,129), liabilities £544,068 (£473,946). Commitments £90,000.

Interim Dividend

Wire Industries Steel Products and Engineering Company is resuming dividends with a 5 per cent interim for the year ending June 30, 1958. A total of 25 per cent, in equal interim and final payments, was distributed for 1955-56.

New Companies

The particulars of companies recently registered are quoted from the daily register compiled by Jordan and Sons Limited, Company Registration Agents, Chancery Lane, W.C.2.

William Kenyon and Sons (Metal Fabrications) Limited (600890), Stamford Garage, Old Street, Ashton-under-Lyne, Lancs. Registered March 19, 1958. To take over business of general fabricators of metal, being part of the business carried on at Dukinfield, Cheshire, by William Kenyon and Sons Ltd., etc. Nominal capital, £125,000 in £1 shares. Directors: George H. Kenyon, James Shepley, Leonard Ardern and James L. Jepson.

J. J. Braimbridge and Son Limited (601295), Hope Works, Studley Street, Hull. Registered March 26, 1958. To take over business of ferrous and non-ferrous metal merchants and dealers, brassfounders and ingot makers carried on as "J. J. Braimbridge and Son" at Hull, etc. Nominal capital, £10,000 in £1 shares. Directors to be appointed by subscribers.

Trade Publications

Sheet Metal Working Machines. — F. J. Edwards Ltd., 359-361 Euston Road, London, N.W.1.

The latest catalogue (SM458) produced by this company describes their Besco sheet metal machines and presses, with a representative range of machine tools, woodworking machines, cutting presses for plastics and other soft materials, and tin boxing machines. A number of illustrations of machines are also included.

Hydraulic Presses. — Reed Brothers (Engineering) Ltd., Replant Works, Woolwich Industrial Estate, London, S.E.18.

Useful leaflets distributed by this firm draw attention to the range of hydraulic presses, in the manufacture of which they are specialists. The range detailed in one leaflet extends from a 15-ton hand operated press right through a series of about a dozen presses up to a 600-ton horizontal roll mandrel forcing press. These presses are illustrated, and it should be noted that a separate leaflet deals with the firm's rebuilt hydraulic presses for all duties.

Welding of Titanium Alloys.—William Jessop and Sons Ltd., Sheffield.

In the latest information sheet distributed by this company, information and recommendations are offered for the welding of Hylite titanium alloys. Up-to-date techniques are set out under the headings of fusion welding, resistance welding, and flash welding. Some useful tabular matter is also included. Copies of this sheet (M783) may be obtained on application to the company.

Measurement and Control Instruments.—Electronic Switchgear (London) Ltd., Works Road, Letchworth, Herts.

Leaflets descriptive of newly-designed equipment for the measure and control of the conductivity of electrolytes such as weak acids, processed water, steam condensate, etc., have recently been issued by this company. These leaflets include data on the units concerned, together with illustrations. The Type RC4 conductivity controller is intended primarily for permanent installation on processing plant, during the operation of which it is required to signal, or to effect corrective action, when the continuously monitored conductivity of an electrolyte reaches a predetermined value. The instrument may also be used to make periodic measurements to enable the state of the process at any time to be accurately appraised.

Power Capacitors. — British Insulated Callender's Cables Ltd., 21 Bloomsbury Street, London, W.C.1.

Advances in the technique of capacitor manufacture are described in a new booklet recently issued by this company dealing with the "MW" power capacitors for 200-600 volt operation. From the illustrations, details, and table given in this booklet it will be seen that it is possible by means of single-, two- and three-tier assemblies to build compact, light and closely-graded capacitor ratings. These capacitors occupy greatly reduced floor space and can be mounted on walls or stanchions, forming a neat assembly which will, it is stated, give years of trouble-free service.

THE STOCK EXCHANGE

Markets Neglected But Prices Remained Steady

ISSUED CAPITAL •	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 27 MAY	+RISE —FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1958 HIGH	1958 LOW	1957 HIGH	1957 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	20/6		10	10	9 15 0	20/6	17/9	28/3	18/–
400,000	2/–	Anti-Attrition Metal	1/6		4	8½	5 6 9	1/6	1/3	2/6	1/6
33,639,483	Stk. (£1)	Associated Electrical Industries ...	48/3	+9d.	15	15	6 4 6	51/–	47/–	72/3	47/9
1,590,000	1	Birfield Industries	47/6	—3d.	15	15	6 6 3	53/9	47/6	70/–	48/9
3,196,667	1	Birmid Industries	63/–	+2/–	17½	17½	5 11 0	65/6	56/3	80/6	55/9
5,630,344	Stk. (£1)	Birmingham Small Arms	28/6		10	8	7 0 3	28/6	23/9	33/–	21/9
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	15/4½		5	5	6 10 0	15/7½	14/7½	16/–	15/–
350,580	Stk. (£1)	Ditto Cum. B. Pref. 6%	16/7½		6	6	7 4 3	17/–	16/6	19/–	16/6
500,000	1	Bolton (Thos.) & Sons	26/3		12½	12½	9 10 6	28/9	26/3	30/3	28/9
300,000	1	Ditto Pref. 5%	15/3		5	5	6 11 3	16/–	15/3	16/9	14/3
160,000	1	Booth (James) & Co. Cum. Pref. 7%	19/3		7	7	7 5 6	19/3	19/–	22/3	18/9
9,000,000	Stk. (£1)	British Aluminium Co.	38/3	+1/3	12	12	6 5 6	46/6	37/–	72/–	38/3
1,500,000	Stk. (£1)	Ditto Pref. 6%	19/–		6	6	6 6 3	19/3	18/4½	21/6	18/–
15,000,000	Stk. (£1)	British Insulated Callender's Cables	43/3	+9d.	12½	12½	5 15 6	44/3	38/9	55/–	40/–
17,047,166	Stk. (£1)	British Oxygen Co. Ltd., Ord. ...	34/9	+1/1½	10	10	5 15 0	35/3	29/–	39/–	29/6 »
600,000	Stk. (5/–)	Canning (W.) & Co.	19/9	—3d.	25+*2½C	25	6 6 6	21/–	19/9	24/6	19/3
60,484	1/–	Carr (Chas.)	2/–		25	25	X8 15 0	2/3	2/–	3/6	2/1½
150,000	2/–	Case (Alfred) & Co. Ltd.	4/3		25	25	11 16 3	4/9	4/1½	4/6	4/–
555,000	1	Clifford (Chas.) Ltd.	17/–		10	10	11 15 3	17/–	16/–	20/6	15/9
45,000	1	Ditto Cum. Pref. 6%	15/10½		6	6	7 11 3		—	17/6	16/–
250,000	2/–	Coley Metals	3/3		25	25	15 7 9	4/6	3/3	5/7½	3/9
8,730,596	1	Cons. Zinc Corp.†	44/3	+6d.	18¾	22½	8 9 6	51/6	43/–	92/6	49/–
1,136,233	1	Davy & United	50/–	+1/3	15	12½	6 0 0	50/–	45/9	60/6	42/6
2,750,000	5/–	Delta Metal	18/6	+6d.	30	*17½	8 2 3	21/4½	17/7½	28/6	19/–
4,160,000	Stk. (£1)	Enfield Rolling Mills Ltd.	32/–		12½	15B	7 16 3	33/–	24/–	38/6	25/–
750,000	1	Evered & Co.	28/–xcap		15	15	7 2 9	28/–	26/–	52/9	42/–
18,000,000	Stk. (£1)	General Electric Co.	30/9	+9d.	12½	14	Y7 9 6	38/7½	29/6	59/–	38/–
1,250,000	Stk. (10/–)	General Refractories Ltd.	32/–		20	17½	6 5 0	33/9	27/3	37/–	26/9
401,240	1	Gibbons (Dudley) Ltd.	66/–		15	15	4 11 0	66/3	64/–	71/–	53/–
750,000	5/–	Glacier Metal Co. Ltd.	6/–		11½	11½	9 11 9	6/3	5/7½	8/1½	5/10½
1,750,000	5/–	Glynwed Tubes	13/4½		20	20	7 9 6	13/6	12/10½	18/–	12/6
5,421,049	10/–	Goodlass Wall & Lead Industries ...	23/3	+10½d.	13‖	18Z	5 11 9	23/3	19/3	37/3	28/9
342,195	1	Greenwood & Batley	46/9		17½	17½	7 9 9	46/10½	45/–	50/–	46/–
396,000	5/–	Harrison (B'ham) Ord.	11/10½		*15	*15	6 6 3	12/4½	11/6	16/9	12/4½
150,000	1	Ditto Cum. Pref. 7%	19/–	+3d.	7	7	7 7 3	19/–	18/9	22/3	18/7½
1,075,167	5/–	Heenan Group	7/3		10	20‡	6 18 0	7/7½	6/9	10/4½	6/9
142,045,750	Stk. (£1)	Imperial Chemical Industries ...	44/–		12Z	10	5 9 0	44/10½	36/6	46/6	36/3
33,708,769	Stk. (£1)	Ditto Cum. Pref. 5%	16/4½	+4½d.	5	5	6 2 3	17/1½	16/–	18/6	15/6
14,584,025	**	International Nickel	139½	+3½	$3.75	$3.75	4 16 9	144½	134	222	130
430,000	5/–	Jenks (E. P.), Ltd.	7/9		27½φ	27½	8 17 6	7/9½	6/9	18/10½	15/1½
300,000	1	Johnson, Matthey & Co. Cum. Pref 5%	16/3		5	5	6 3 0	16/3	15/–	17/–	14/6
2,987,435	1	Ditto Ord.	44/–	+6d.	10	9	4 11 0	44/6	37/6	58/9	40/–
600,000	10/–	Keith, Blackman	16/3		15	15	9 4 6	16/3	15/–	21/9	15/–
160,000	4/–	London Aluminium	3/–		10	10	13 6 9	4/3	3/–	6/9	3/6
2,400,000	1	London Elec. Wire & Smith's Ord. ...	43/–		12½	12½	5 16 3	43/9	39/9	54/6	41/–
400,000	1	Ditto Pref.	22/6	+3d.	7½	7½	6 13 3	22/9	22/3	25/3	21/9
765,012	1	McKechnie Brothers Ord.	32/–		15	15	9 7 6	35/–	32/–	48/9	37/6
1,530,024	1	Ditto A Ord.	30/9		15	15	9 15 0	32/6	30/–	47/6	36/–
1,108,268	5/–	Manganese Bronze & Brass	9/6		20	27½‡	10 10 6	10/6	9/–	21/10½	7/6
50,628	6/–	Ditto (7½% N.C. Pref.)	6/–		7½	7½	7 10 0	6/3	5/9	6/6	5/–
13,098,855	Stk. (£1)	Metal Box	50/–	+6d.	20‡	15M	4 0 0	50/–	41/9	59/–	40/3
415,760	Stk. (2/–)	Metal Traders	7/–	+1½d.	50	50	14 5 9	7/–	6/3	8/–	6/3
160,000	1	Mint (The) Birmingham	20/–		10	10	10 0 0	22/9	20/–	25/–	21/6
80,000	5	Ditto Pref. 6%	81/6		6	6	7 7 6	83/6	81/6	90/6	83/6
3,064,930	Stk. (£1)	Morgan Crucible A	38/6		10	11	5 4 0	40/–	34/–	54/–	35/–
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	17/–		5½	5½	6 9 6	17/3	17/–	19/3	16/–
2,200,000	Stk. (£1)	Murex	55/–	+6d.	20	20	7 5 6	57/6	53/3	79/9	57/–
468,000	5/–	Ratcliffs (Great Bridge)	7/3		10	10	6 18 0	7/3	6/10½	8/–	6/10½
234,960	10/–	Sanderson Bros. & Newbould ...	25/6	—1/6	27½D	27½	7 3 9	27/–	25/6	41/–	24/9
1,365,000	Stk. (5/–)	Serck	12/6	—1½d.	17½Z	15	4 13 3	12/7½	11/–	18/10½	11/6
600,400	Stk. (£1)	Stone (J.) & Co. (Holdings)	43/9		16	16	7 6 6		—	57/6	43/9
600,000	1	Ditto Cum. Pref. 6½%	20/–		6½	6½	6 10 0	20/9	20/–	21/9	18/9
14,494,862	Stk. (£1)	Tube Investments Ord.	54/–	+1/–	15	15	5 11 0	54/6	48/4½	70/9	50/6
41,000,000	Stk. (£1)	Vickers	30/1½		10	10	6 12 9	32/6	29/4½	46/–	29/–
750,000	Stk. (£1)	Ditto Pref. 5%	15/–		5	5	6 13 3	15/6	14/9	18/–	14/–
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	21/3		*5	*5	7 4 9A	23/–	21/3	24/9	20/7½
2,200,000	1	Ward (Thos. W.), Ord.	73/9	+6d.	20	15	5 8 3	76/3	70/9	83/–	64/–
2,666,034	Stk. (£1)	Westinghouse Brake	38/9	+9d.	10	18P	5 3 3	38/9	32/6	85/–	29/1½
225,000	2/–	Wolverhampton Die-Casting ...	7/4½	+3d.	25	40	6 15 6	8/–	7/1½	10/1½	7/–
591,000	5/–	Wolverhampton Metal	17/3		27½	27½	7 19 6	17/7½	14/9	22/3	14/9
78,465	2/6	Wright, Bindley & Gall	3/6		20	17½E	14 5 9	3/9½	3/3	3/9	2/7½
124,140	1	Ditto Cum. Pref. 6%	11/6		6	6	10 8 9		—	12/6	11/3
150,000	1/–	Zinc Alloy Rust Proof	2/10½		40D	33½	9 5 6	3/1½	2/7½	5/–	2/9

*Dividend paid free of Income Tax. †Incorporating Zinc Corpn. & Imperial Smelting **Shares of no Par Value. ‡ and 100% Capitalized Issue. •The figures given relate to the issue quoted in the third column. A Calculated on £7 14 6 gross. M and 10% capitalized issue. Y Calculated on 11½% dividend. ‖Adjusted to allow for capitalization issue. E for 15 months. P and 100% capitalized issue, also "rights" issue of 2 new shares at 35/– per share for £3 stock held. D and 50% capitalized issue. Z and 50% capitalized issue. B equivalent to 12½% on existing Ordinary Capital after 100% capitalized issue. φ And 100% capitalized issue. X Calculated on 17½%. C Paid out of Capital Profits.